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Prepared by

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Bureau of Land Management
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WILLOW CREEK INTERDISCIPLINARY WATERSHED ACTIVITY PLAN/ENVIRONMENTAL ASSESSMENT

This Draft Environmental Assessment evaluates the effectiveness of runoff control structures in the Willow Creek Basin in northeastern Montana. After considering these structures and BLM land use objectives, the document describes four management alternatives, including a proposed alternative, for this basin.

Alternative 1 — No Action, would be described as continued management at present levels and is required by Council of Environmental Quality regulations. Alternative 2 — Abandonment, would abandon all the runoff control structures with mitigations, primarily road reroutes, being the only costs. This is the proposed alternative. Alternative 3 — Reconstruction and Major Enhancement, would mean that all the structures would be maintained for the 50 year life of the plan. Alternative 4 — Prioritized Structure/System Management, would maintain those structures identified as having high resource values. These alternatives are analyzed for both a short-term implementation period (10 years) and the long-term planning period (50 years).

The general location of this basin is shown on Figure 1.2 in Chapter 1.

For further information contact Glenn Freeman, District Manager, Lewistown District Office, Bureau of Land Management, Airport Road, Lewistown, Montana 59457, (406) 538-7461.

Department of the Interior

Bureau of Land Management — Lewistown District Office

Draft

Willow Creek Interdisciplinary Activity Plan/Environmental Assessment

After examining the four alternatives in this Environmental Assessment, the Bureau of Land Management proposes to abandon the structures/systems in the Willow Creek Basin. With this alternative there would be no further maintenance or improvement applied to any of the structures/systems. The only costs of implementing this alternative are those associated with resource mitigations. The types of mitigations considered with this alternative include revegetation, livestock watering facility relocation and road rerouts.

The environmental impacts of this proposal are best described in the long-term (50-year) life of the plan.

The flood runoff from a 100 year storm would increase from 4,710 cubic feet per second (cfs) to 22,400 cfs. The sediment storage capability of the structures/systems would remain the same but the life of this storage ability would decrease from 18 years to 10 years.

There would be reductions in the amount of herbage and the number of livestock watering facilities. However, these impacts would be mitigated.

All of the structures/systems would eventually become of low value to wildlife. Big game populations would decrease by 10%, upland gamebirds by 20% and waterfowl populations would decrease by 70%.

There would be a minor decrease in the amount of big game related recreation, a moderate decrease in upland game birds related recreation and a significant decrease in waterfowl related recreation.

The other alternatives analyzed in this assessment include: No Action (Continued Management); Reconstruction and Major Enhancement; and Prioritized Structure/System Management.

Draft Environmental Assessment

June, 1985

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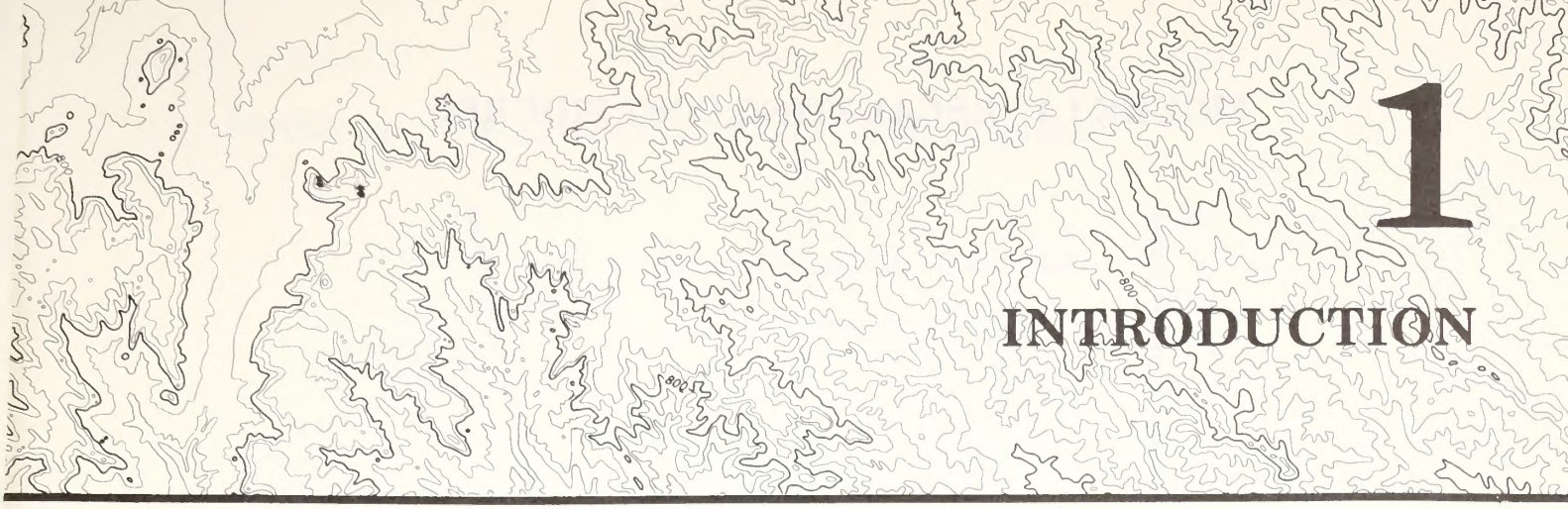


1 INTRODUCTION

PURPOSE AND NEED

The purpose of this document is to evaluate the effectiveness of runoff control structures (regarding flood peak attenuation and subsequent reductions in sediment yield) in the Willow Creek Basin and to make a management recommendation based on that evaluation.

This Environmental Assessment (EA) is needed in order to provide future the management direction pertinent to these structures. Considering this evaluation and Bureau of Land Management (BLM) land use objectives, the document provides four management alternatives. This document will be used as a Programmatic Environmental Assessment for future management of the existing watershed conservation structures in the Willow Creek Basin.

According to National Environmental Policy Act (NEPA) requirements, this EA contains an environmental assessment of the existing situation in the Willow Creek Basin and an environmental consequences analysis.

The Valley Resource Area Management Framework Plan (MFP) recommended an EA of this nature for the Willow Creek Planning Unit. Recommendations for watershed studies and related applications (land use plans, memoranda and flood damage reports) cite the need for better defined management action in this basin.

BACKGROUND

The Conservation Plan for Willow Creek was developed in 1952, by the BLM Montana State Office and called for extensive development using runoff control structures. The original estimated cost of implementing the plan was $850,000. By 1983, the investment in construction and maintenance costs had reached $1.8 million ($1.4 million in 1952 dollars).

The authority for developing this original Conservation Plan was the Taylor Grazing Act of 1934 which called for protection and rehabilitation on public lands in order to prevent soil deterioration. This act further emphasized studies of flood and erosion control.

Some of the larger structures constructed include detention reservoirs and water spreading dike systems. These dams and dike systems currently range from 14 to 34 years old and significant maintenance is now required to keep them operating properly.

The cost of maintenance is creating the need for additional management direction. During the construction period costs were significantly less than they are today. Since the useful life of these projects, given routine maintenance, was expected to exceed 50 years, it seemed an inexpensive method of achieving watershed conservation objectives.

High inflation during the last 15 years has elevated maintenance costs drastically. Figure 1.1 is a graphic presentation of these escalating costs. Because of the current high costs, the available expenditures for maintenance have not been able to keep up with the maintenance needs. The lack of funding for maintaining these structures/systems has compounded many minor problems over the last 10 years. In some instances, this lack of maintenance has resulted in the complete failure of various structures/systems.

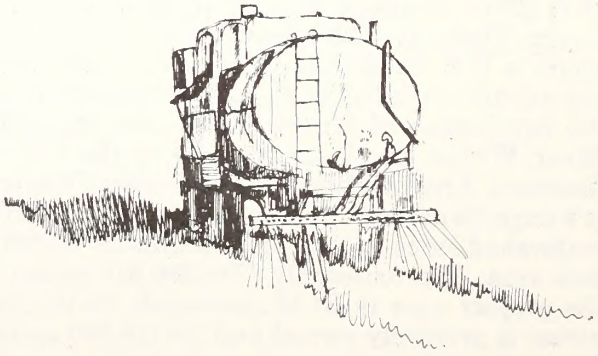
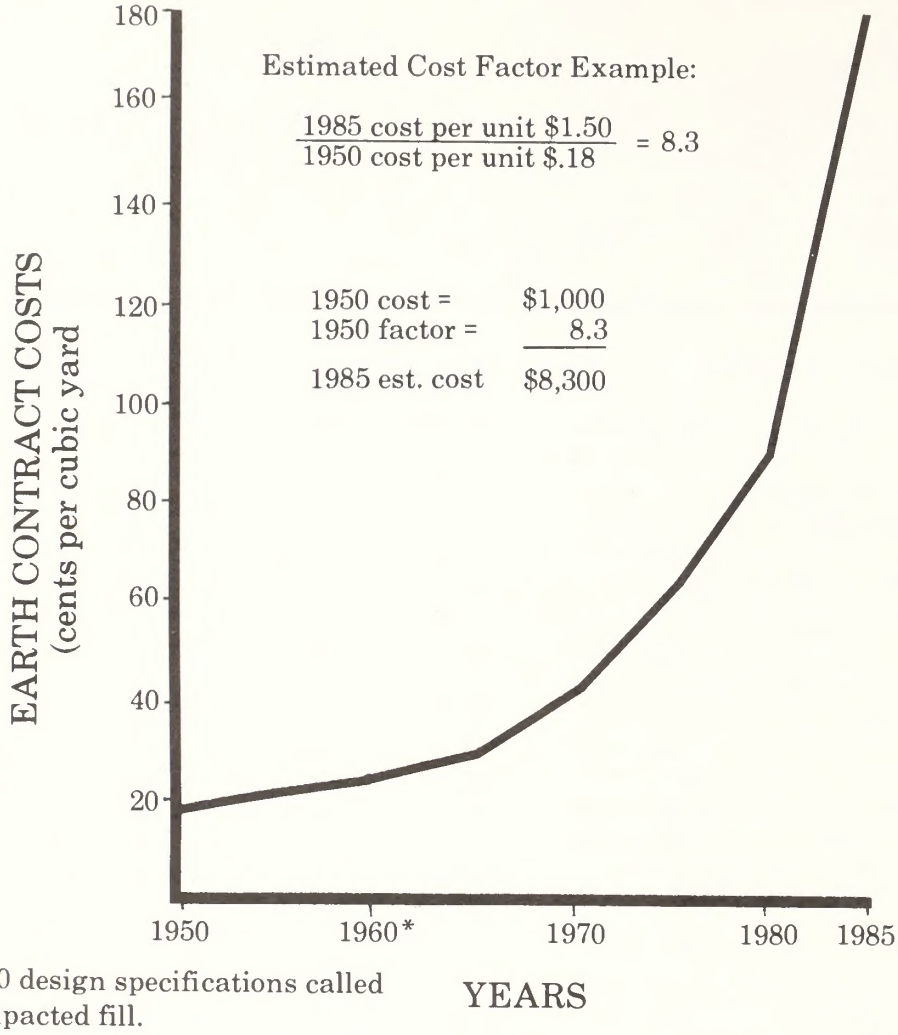


FIGURE 1.1 ESCALATING COST FIGURES



* By 1960 design specifications called for compacted fill.

Source: Official contract files bid price/payments, 1950-1984

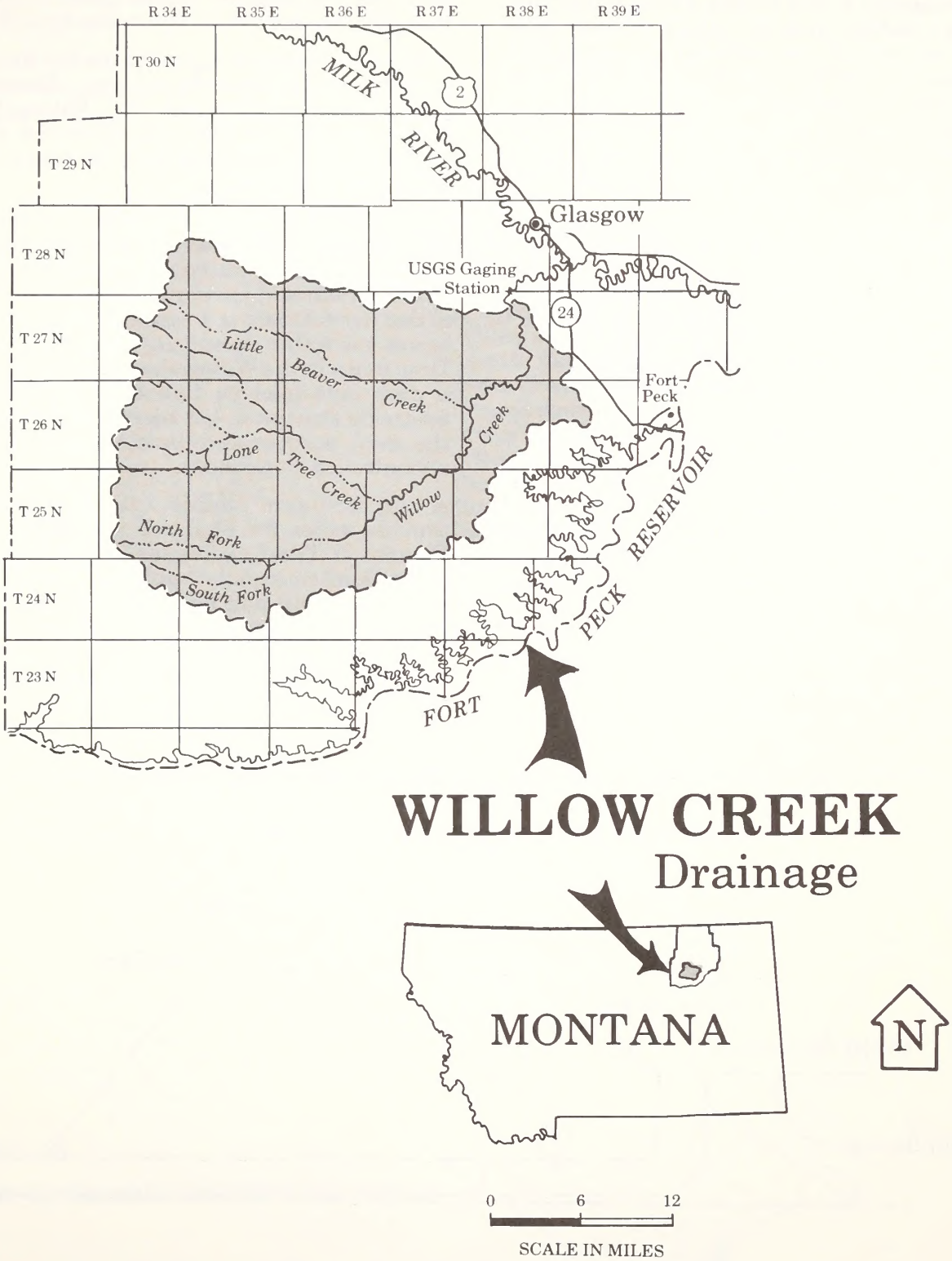
SETTING

Willow Creek is located in northeastern Montana near Glasgow (see Figure 1.2 and the 1:100,000 scale folding map which shows the basin, structures/systems, hydrologic boundaries and access roads). It's a tributary of the Milk River, which is within the Missouri River Basin. There are 538 square miles of drainage above a U.S. Geological Service (USGS) gauging station, located 10.6 miles upstream from the confluence of Willow Creek and the Milk River. Willow Creek is managed by the Valley Resource Area, within the Lewistown District. It's important for BLM to properly manage this watershed since public land dominates the surface area. Approximately 87% (300,615 acres) of the project area is BLM managed, 7% (25,125 acres) is privately owned and 6% (18,580 acres) is state owned. Nearly all the public lands in this basin are included in existing or proposed allotment management plans.

Eighty-three reservoirs and nine spreader systems have been constructed to detain flows during major flood events, reduce sediment yield and prevent or slow the degree of gully formation along the watershed and its tributaries. The watershed structures vary in stages of maintenance needs because of the various problems resulting from the lack of maintenance. These problems are described later in this chapter. All have accumulated deep deposits of sediment; many have filled with sediment.

One hundred and fifty-eight additional reservoirs are stockwater structures maintained by grazing permittees. These permittee-maintained reservoirs are not considered in the scope of this EA.

FIGURE 1.2 WILLOW CREEK BASIN — LOCATION MAP



DESCRIPTIONS OF STRUCTURES/SYSTEMS

There are 92 watershed conservation structures/systems in the Willow Creek Basin consisting of detention dams, diversion dams, drop dams, retention dams and water spreading dike systems. The term structure in this EA most often refers to a detention dam, however, several drop and diversion dams are also included. The term system refers to a set of water spreading dikes with accompanying drop, diversion and retention dams.

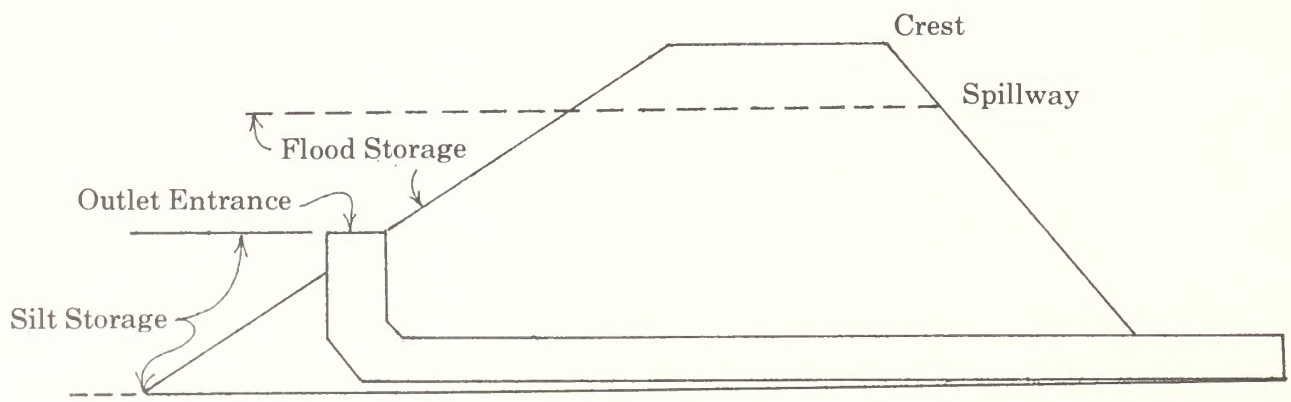
A detention dam controls runoff by holding back a certain design flood event, without the use of an emergency spillway. It also uses an outlet to release flood runoff over a designed period of time (5-10 days) reducing peak flows to protect downstream areas (see Figure 1.3). A dam with a large reservoir surface area at the pipe inlet, such as Triple Crossing Reservoir or Grub Reservoir, will provide wier flow for a much longer period after a flood event. Drawdown of the designed flood event over the 5-10 day-design period slows and mitigates the force of flowing water, greatly reducing the transport of sediment to downstream areas. The downstream end of the pipe is located on the channel bottom so the energy of falling water is dissipated. Upstream progress of any headcut stops at the dam. Detention dams are designed to store little or no water except during and immediately after a flood event. Detention dams may be designed with certain "dead storage," but this area is expected to fill with sediment within 25 years. The original Willow Creek Conservation Plan depended heavily on this type of dam.

A diversion dam is designed to modify the direction of flow of water and not designed to retain a permanent pool of water. The Willow Creek Basin contains a few true diversion dams, primarily in conjunction with the major water spreading dike systems.

A drop dam is designed to release water from one elevation to a lower elevation, dissipating the force of falling water, and is used to stabilize channels where channel gradients are steep and active headcutting is a result. A drop structure stores no water except during a flood event. Drop dams in the Willow Creek Basin all utilize a drop pipe inlet as flow is controlled from upstream structures, but wiers and chutes serve the same purpose and handle larger flows on uncontrolled watersheds.

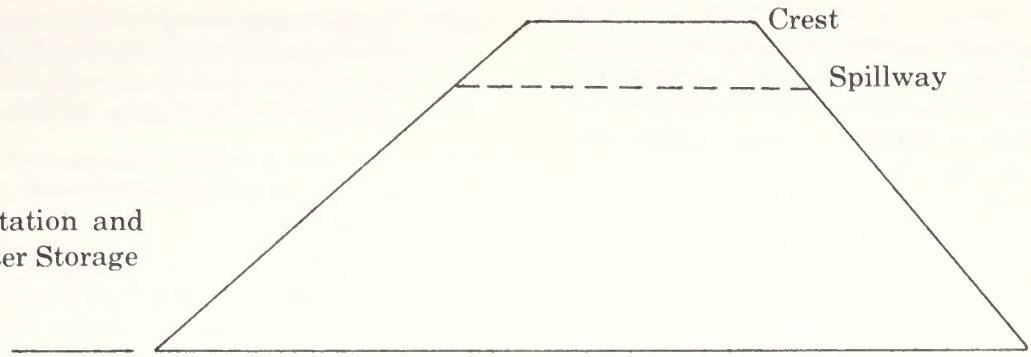
A retention dam retains watershed runoff to provide water for livestock and wildlife (see Figure 1.4). These dams usually have no outlets other than emergency spillways. These structures are small and short-lived in the Willow Creek Basin because of high sediment yields. Outlets may be installed to reduce spillway erosion and extend the life of the structure.

FIGURE 1.3 DETENTION DAM



Source: BLM 1985

FIGURE 1.4 RETENTION DAM



A typical water spreading dike system in the Willow Creek Basin utilizes a detention or diversion dam to pool and divert water, a series of dikes to spread water over the valley floor and a drop dam to reduce the force of falling return water (see Figure 1.5). Floodwater is pooled and released into the dike system through a pipe for the designed number of days. Water spreaders throughout the dike system provide water for increased soil moisture and vegetation. Water flowing through the system is then dropped back to the original channel elevation by a drop dam, stopping upstream headcutting.

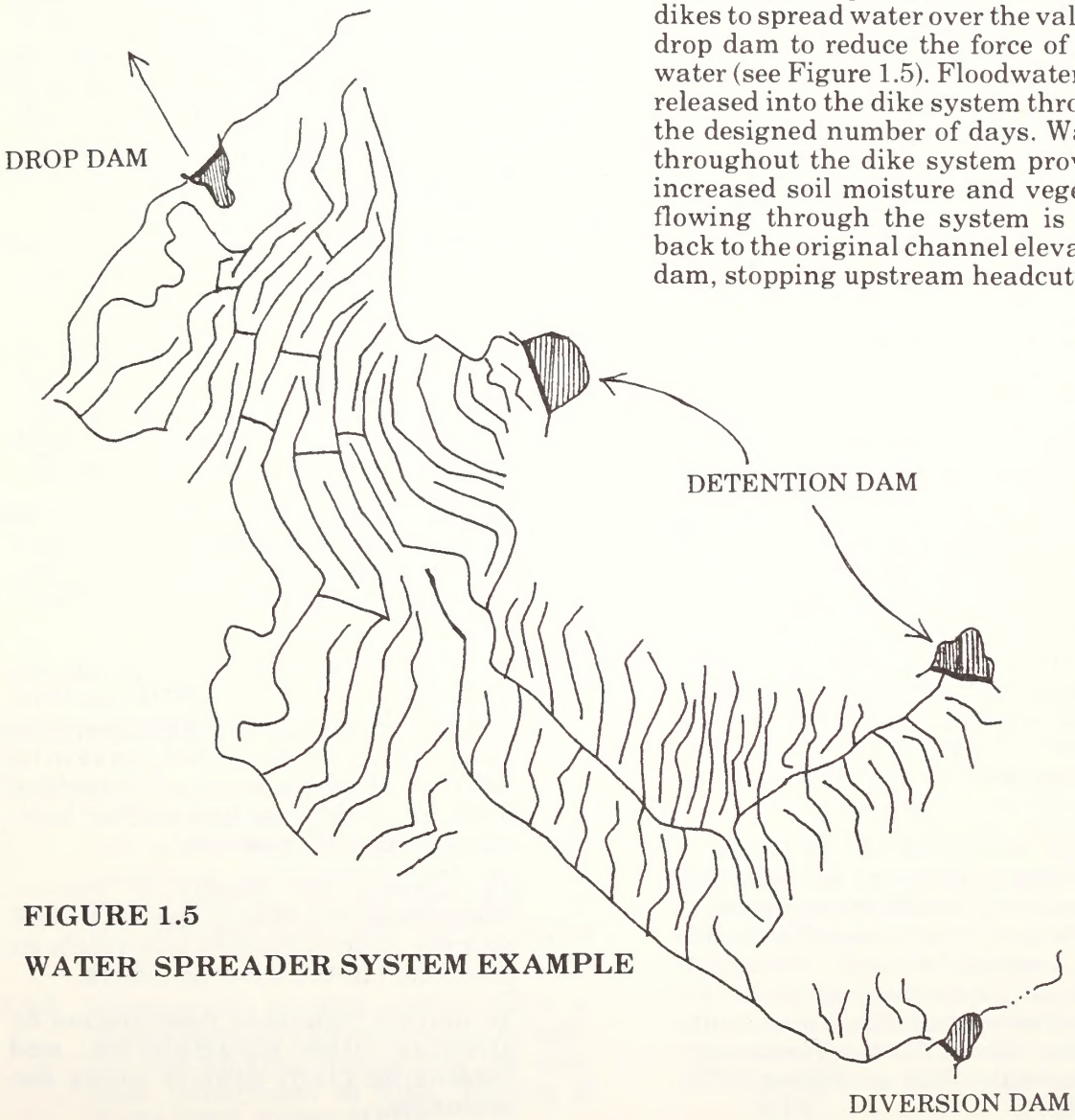


FIGURE 1.5

WATER SPREADER SYSTEM EXAMPLE

LAND USE OBJECTIVES

This section describes the resource objectives which guided the construction of these 92 structures/systems. These objectives are organized as they relate to watershed, recreation and access, livestock grazing and wildlife. The compilation of these objectives begins with the original 1952 Willow Creek Conservation Plan and continues through more current land use decisions.

These objectives are the result of 32 years of issue identification, BLM staff and public efforts, as well as being the subject of several management framework plans and two major environmental impact statements. Each was considered while formulating the alternatives given later in this document.

A more detailed analysis of these objectives can be found in the planning document noted at the conclusion of each objective summary.

WATERSHED (WS)

WS 1 Control flows of the Willow Creek drainage from its headwaters to its confluence with the Milk River (1952, Willow Creek Conservation Plan).

WS 2 Reduce erosion, control runoff, and decrease sediment yield (1952, Willow Creek Conservation Plan).

WS 3 Afford protection to the Willow Creek — Milk River area from severe flooding (1952, Willow Creek Conservation Plan).

WS 4 Develop a long-range watershed plan from inventory data and analysis and recommend watershed needs from the standpoint of soil physical-chemical properties, vegetation cover, grazing, climate, erosion and cost-benefits. Also make recommendations on the need, placement, and maintenance of watershed structures (detention dams and dikes and watershed tillage) (1978, Valley MFP).

WS 5 Delay any watershed tillage practices until adequate grazing management (grazing system) has been implemented and sufficient vegetation-soils studies have been established and information obtained and evaluated which establishes that watershed tillage treatments are the only alternative to improvement of existing watershed conditions (1978, Valley MFP).

WS 6 Delay decisions on water control structures until such time as sufficient inventory and planning information is obtained (1978, Valley MFP).

WS 7 Conduct a water resource inventory for non-point pollution sources (1978, Valley MFP).

WS 8 Conduct intensive inventory for vegetation condition, soil condition, watershed condition, grazing history and analysis of studies (1978, Valley MFP).

WS 9 Allocate any future increased herbage production for the purpose of watershed protection and improvement (1978, Valley MFP).

WS 10 On allotments in predominantly fair ecological range condition, implement improved grazing systems that periodically defer early season livestock use (4/1 to 5/15) in addition to land treatments and grazing management techniques keyed to specific soil subgroups to improve cover and reduce soil compaction (1981, Prairie Potholes EIS).

WS 11 For all floodplains, protect and enhance water quality and retard flooding severity (1981, Prairie Potholes EIS).

WS 12 For all low value reservoirs used primarily for wildlife and livestock, maintain water quality to meet or exceed minimum state and Federal water quality standards (1981, Prairie Potholes EIS).

WS 13 Prevent serious watershed deterioration by increasing litter, density, and composition of plants on the drainages (Coyote Creek AMP and 1976, Missouri Breaks EIS).

WS 14 The overall objective of this plan (Lewis Reservoir and Bomber AMPs and 1976, Missouri Breaks EIS) is to improve the range resource so that it may serve in its full capacity for watershed protection, livestock production, and wildlife habitat. Specific objectives are:

To increase the density of western wheatgrass, the desired species by 30% over the entire allotment and double its production in the water spreaders.

To prevent watershed deterioration by allowing litter accumulation, and increasing plant density along the drainages.

To provide increased vegetation density along reservoir shorelines and throughout the water spreaders. The rotation systems of grazing should accomplish this.

WS 15 The objectives of this allotment management plan (Lower Willow Creek AMP and 1976, Missouri Breaks EIS) are as follows:

To prevent serious watershed deterioration through an increase of plant cover and composition throughout the allotment by reducing the soil surface factor of Area No. 1 from 61 to 51 and Area No. 2 from 51 to 41.

To decrease the amount of bare ground from 45% to 41% in Areas No. 1 and No. 2 respectively to 30%. This should be reached in approximately 20 years.

WS 16 To prevent further serious watershed deterioration by increasing litter, density, and composition of plants throughout the allotment (Miller Coulee AMP and 1981, Prairie Potholes EIS).

WS 17 To halt gully erosion along the old Jeep Trail along the east part of Secs. 24, 25, T. 27 N., R. 37 E. This will be accomplished by constructing small check dams across the old trail. This coupled with the rest-rotation grazing system should allow vegetation to re-establish in the ruts (Miller Coulee AMP and 1981, Prairie Potholes EIS).

WS 18 To reduce soil erosion and sedimentation in each unit by increasing vegetation density, plant litter, and desirable plant species (Willow Creek, Lone Tree and Lower Beaver Creek AMPs and 1976, Missouri Breaks EIS).

RECREATION ACCESS (RA)

RA 1 All management decisions shall give sufficient consideration to recreational and wildlife oriented values to insure the protection, enhancement and perpetuation of hunting, fishing and other wildlife oriented activities (1978, Valley MFP).

RA 2 Increase the hunting opportunities in the resource area by improving the habitat and working closely with the Montana Department of Fish, Wildlife & Parks (1978, Valley MFP).

RA 3 Increase hunting opportunities by improving the habitat along creek bottoms. These critical areas should be considered when writing AMPs (activity plans) and when possible all creeks should be included in one pasture (1978, Valley MFP).

RA 4 Maintain essential roads and trails necessary for public access to NRL for the utilization of fish and wildlife resources (1978, Valley MFP).

LIVESTOCK GRAZING (LG)

LG 1 Initiate range improvement projects (i.e. stockwater) to effectively implement grazing systems (1976, Missouri Breaks and 1981, Prairie Potholes EISs).

LG 2 Improve or maintain range condition to 80% good and excellent (1981, Prairie Potholes and 1976, Missouri Breaks EISs).

WILDLIFE (WL)

WL1 Maintain, through current management practices and methods, the present density and height of big sagebrush and associated herbaceous cover on areas identified as crucial, high value and medium value sage grouse and antelope habitat (1978, Valley MFP).

WL2 For sage grouse habitat, sagebrush should be maintained at a density with a minimum cover value of 20% canopy coverage or greater with height classes of 10-14 inches. This is especially critical on ridges, basins and slopes. Curtail all surface disturbance within a 2-mile radius of all known strutting grounds and intensify inventories to locate additional grounds (1978, Valley MFP).

WL3 Increase waterfowl nesting and brood-rearing habitat (breeding habitat) on NRL in Valley County on all potential sites. Improve the existing reservoirs with goose nesting potential (250) by providing nesting island and improving nesting cover which will triple goose production within 10 years (1978, Valley MFP).

WL4 Develop additional waterfowl habitat on NRL by increasing reservoir and pond development larger than 3 surface acres on all suitable sites. Modify existing reservoirs for goose production by incorporating island development in the design during low-water level periods (1978, Valley MFP).

WL5 Continue to maintain sport fisheries in existing reservoirs (refer to location list below). Development of additional sites for fisheries habitat should be in close proximity to existing fishing reservoirs (1978, Valley MFP).

Gutshot	Sec. 34, T. 26 N., R. 37 E.,	N. Pike
Lone Tree Res.	& Channel	N. Pike
Whitetail Res.	Sec. 5, T. 25 N., R. 36 E.,	Largemouth Bass
January Res.	Sec. 24, T. 27 N., R. 38 E.,	Largemouth Bass

WL6 Limit mechanical land treatment practices. Such treatments will be considered only after it has been determined that the desirable results cannot be attained through grazing management. Thoroughly evaluate the effects on wildlife before treatment is initiated. Revegetate with native plant species preferred by wildlife when possible (1976, Missouri Breaks EIS).

WL7 By 2003, improve or maintain the ecological range condition of all riparian zones of all water bodies not identified for waterfowl or fisheries values to at least good ecological range condition on all AMP allotments (1981, Prairie Potholes EIS).

WL8 Maintain big sagebrush with 15-50% canopy cover and over 12 inches in height and silver sagebrush with greater than 10% canopy cover and over 15 inches in height within 2 miles of sage grouse leks and on designated winter range for sage grouse and antelope. Maintain a diversity of forbs, grasses, and shrubs on the summer ranges to provide for 7,125 — 9,500 antelope (1981, Prairie Potholes EIS).

WL9 Within 1½ miles of a sharp-tailed grouse lek maintain or improve woody vegetation and give careful consideration in location of water improvements (1981, Prairie Potholes EIS).

Table 1.1 illustrates which of these objectives are to be accomplished by this activity plan, through other forms of activity planning or have already been fully accomplished.

TABLE 1.1: MANAGEMENT OBJECTIVES (MO) TO BE ACCOMPLISHED BY THIS ACTIVITY PLAN, OTHER ACTIVITY PLANS OR ALREADY FULLY ACCOMPLISHED

M.O. Numbers	MO Met By This Plan	MO Met By Other Means (Forms of Act. Planning)	MO Fully Accomplished	MO Met By Alternative
WS 1	X	X		1,3,4
WS 2	X	X		1,3,4
WS 3	X			1,3,4
WS 4	X			1,2,3,4
WS 5		X		—
WS 6	X			1,2,3,4
WS 7			X	—
WS 8	Continuous	Continuous	Continuous	1,2,3,4
WS 9	X	X		1,2,3,4
WS 10		X		—
WS 11		X		—
WS 12		X		—
WS 13		X		—
WS 14		X		—
WS 15		X		—
WS 16		X		—
WS 17		X		—
WS 18		X		—
RA 1	X	X		1,3,4
RA 2	X	X		3,4
RA 3	X	X		3,4
RA 4	X	X		1,2,3,4
LG 1	X	X		3,
LG 2	X	X		1,2,3,4
WL 1	X	X		3,4
WL 2	X	X		3,4
WL 3	X	X		1,3,4
WL 4	X	X		1,3,4
WL 5	X	X		—
WL 6	X	X		3,4
WL 7	X	X		—
WL 8	X	X		1,3,4
WL 9		X		—

PROBLEMS RESULTING FROM LACK OF MAINTENANCE

Observations of these 92 structures/systems, all of which have been functional for at least 14 years, have enabled an accurate assessment of the major problems. Other than normal deterioration and lack of routine maintenance, the most prominent maintenance problems are due to one or any combination of the following (listed in the order of seriousness):

PIPE CORROSION

It is increasingly evident that corrugated metal pipe, used in almost every Willow Creek structure/system, is highly susceptible to early failure due to the intensively corrosive soils common in this basin. Several corrugated metal pipes have failed, due to corrosion, within 20 years of their installation. Since the majority of the pipes used in the construction projects have been installed for 20 to 30 years, it's anticipated that 20 to 25 dams could fail within the next 10 years. Several vulnerable reservoirs pipe water to spreading dike systems thus, the water spreading systems are also in jeopardy due to corroded and failing pipes.

SILTATION

Silt deposits in quantities far beyond the anticipated yields have occurred in some basins. This silt reduces flood storage capacity to such a degree that above normal spillway flows are causing spillway failures. It's anticipated that unless modified by increasing flood storage capacity or installing large outlet pipes, these spillways may suffer serious damage within the next 10 years.

CONCRETE HEADWALLS

The majority of the detention reservoirs utilize a concrete headwall, installed at the top of a riser pipe, to prevent vortex action erosion and to enable the installation of a trash rack. Eventually, these concrete headwalls cracked away from the pipe and were slowly undermined of supporting soil.

The weight of the concrete headwall begins to rely fully on the riser pipe. This results in crushing the riser pipe's pedestal, consequently causing pipe failure. It's anticipated that unless modified by removing these headwalls, 10 to 15 structures will sustain serious damage due to this type of problem during the next 10 years.

ENERGY DISSIPATION

Each reservoir with a large diameter (42″ or larger) outlet pipe, without energy dissipators, has developed excessively large tailwater pools (glory holes). The force of such a large discharge of water undermines the downstream pipe, causing it to break off. Flows erode a large tailwater pool and further erode the downstream slope of the dam causing eventual failure. It's anticipated that unless modified by the use of concrete or some other type of dissipator, several major dams may fail due to the lack of downstream energy dissipation.

SLOPE PROTECTION

Severe wave action will damage major dams without slope protection. Continual removal of earthen material by erosive wave action will eventually lead to breaching. Presently, there are no known structures in serious jeopardy due to wave action damage. However, this is a continuous problem on reservoirs that store a permanent pool of water without slope protection.

VANDALISM

Three detention reservoir outlet pipes have been intentionally plugged by vandals, in an effort to retain water. Since these dams were not designed to permanently store water up to the spillway elevation, serious damage and headcutting in the spillway is occurring in all cases. All of these reservoirs are subject to serious wave action damage and eventual failure.

WATER SPREADER DIKE DETERIORATION

The water spreading dike systems are susceptible to failure due to many of the previously described problems. Although the dikes are badly deteriorated due to maintenance neglect, there are other reasons for their accelerated declines in condition. Rodent damage, the high shrink-swell range of the clay materials, livestock trailing, rapid siltation and wind and water erosion are common problems for these systems.

MANAGEMENT CONCEPT AND PLANNING PROCESS

Management's concept of the Willow Creek Interdisciplinary Watershed Activity Plan/ Environmental Assessment is to arrive at decisions about the future management of 83 reservoirs and 9 diking systems in the Willow Creek Basin, while considering multiple resource values, objectives and opportunities associated with these structures.

The cost efficient, long-term management options for the watershed structures/systems are to: (1) maintain the structures/systems for long term use; (2) modify or improve the structures/systems; or (3) to abandon them, over a period of time, with the minimum investment needed to protect the resource values present.

The products of this activity plan include: (1) assigning a management option for each structure/system; (2) identifying multiple resource values and opportunities associated with managing the structures/systems; and (3) implementation (including prioritization of individual or group of structures/systems).

In order to reduce the complexity and expedite the planning process, this EA addresses certain components in a general way. Engineering information includes only general costs and construction proposals, and not site specific survey and design. Survey and design would occur as an alternative is implemented, based upon priorities of need and the annual budget.

In the environmental analysis portions of this document, the resource specialists used the best information currently available but in some cases, the analysis may be some degree less than optimum. Any site specific inventories required to mitigate impacts (i.e. cultural) can and will be done during implementation.

CONCERNS OR INTERESTS FROM OTHER GOVERNMENT AGENCIES AND PRIVATE INDIVIDUALS

The 12 permittees who have allotments in the Willow Creek Basin were sent questionnaires asking their opinion on the watershed structures in the basin (see Appendix 1.1). Four questionnaires were returned and several other permittees talked to Valley Resource Area resource specialists. These contacts indicated the reservoirs should be maintained and/or improved and the water spreader systems maintained. The modifications recommended include additional stockwater, contour furrowing and seeding the reservoirs.

The Valley County Commissioners were given an outline of the EA and were informed that it would be presented to them when completed. No comments were received at that time.

Itemized below are some general responses from various resource specialists, representing other agencies, when asked for their opinions about the effectiveness of detention/retention structures in similar situations.

1. Offsite storage for flood control is always encouraged as funding permits.
2. The Glasgow area should not be a major BLM concern, as it relates to risks from management actions in Willow Creek. Glasgow is protected by a levee system and Willow Creek's confluence to the Milk River is located downstream from Glasgow.
3. Recommendations were given to BLM to abandon such structures/systems, as similar projects are usually expensive and cost ineffective. No methodologies for abandonment were offered.
4. The BLM has an obligation to Valley County to consider all risks and impacts from the management of flood control structures/systems in Willow Creek.

2

THE ALTERNATIVES

INTRODUCTION

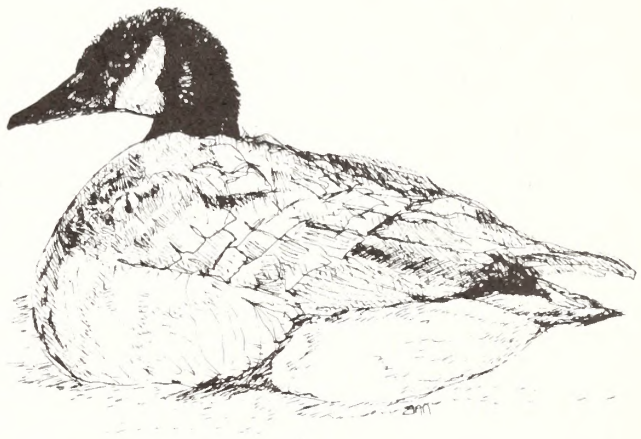
This chapter describes four management alternatives in order to provide readers and decision-makers a means of examining a combination of management actions. This chapter also includes: (1) a discussion of the alternative development process; (2) descriptions of the alternatives considered but not analyzed; and (3) descriptions of the four management alternatives that detail feasibilities, risks and approximate engineering costs.

A table at the conclusion of this chapter summarizes each alternative. These alternatives are further analyzed in Chapter 4, Environmental Impacts.

ALTERNATIVE DEVELOPMENT PROCESS

Since this Environmental Assessment (EA) had the potential of becoming very complex, a management decision was made to develop broad alternatives, applicable to the full array of structures/systems now existing in the basin. Refer to Table 2.1 for a complete list of these reservoirs and water spreading dike systems and their legal descriptions. Each alternative treats the 92 structures/systems listed in this table as a collective set of water control structures. By formulating four broad alternatives, the confusion of writing several EAs, or the development of many alternatives based on varying arrangements of 92 structures/systems was avoided. Each alternative contains a management recommendation for each structure/system.

The land use objectives given in Chapter 1 were considered by a core team of resource specialists while formulating each alternative. However, the alternative descriptions do not specifically identify individual objectives or groups of objectives.



Each reservoir, or water spreading dike system, was rated according to individual resource values. The four resources participating in the rating system were watershed, range, wildlife and recreation. Appendix 2.1 details the procedures used to develop these value ratings. All structures/systems were rated for their existing and potential values.

The planning team (composed of management and staff specialists) used the value ratings while developing Alternatives 2, 3 and 4. Alternative 2, an abandonment option, proposes abandonment of every structure/system. Resource value ratings were used in this alternative to determine which of those structures/systems would be significant enough to warrant mitigative efforts (livestock watering developments, mechanical treatments to replace forage cost and road reroutes). The total mitigative cost is the cost of Alternative 2. Alternative 3, a maximized resource value option used potential resource value ratings extensively, while Alternative 4, with a moderate resource development approach, used mostly existing resource value ratings. While developing Alternative 4, watershed values received a higher priority than the other resource values.

Alternative 1, The No Action or Continued Management Alternative, includes all the structures/systems in the project area and did not require a rating system.

TABLE 2.1: WILLOW CREEK WATERSHED STRUCTURES/SYSTEMS

Detention Structures	Number	Legal Location
1. Tomahawk Det. Dam	0770	27 N., 37 E., NESE 24
2. Grub Det. Res.	0789	27 N., 37 E., SWSE 35
3. Upper Lone Tree Det. Res.	0811	27 N., 35 E., SENW 35
4. Brazil Divide Det. Res.	0814	27 N., 36 E., SENE 1
5. Beaverette Det. Res.	0816	27 N., 37 E., SESW 18
6. NW Burnett Det. Res.	0817	27 N., 35 E., NESW 24
7. Lower Burnett Headcut Det. Res.	0818	27 N., 36 E., NENE 29
8. SW Burnett Det. Res.	0819	27 N., 35 E., SESE 26
9. Bugle Det. Res.	0821	27 N., 35 E., SESW 26
10. Hamms Det. Res.	0869	27 N., 36 E., SESE 9
11. North Beaver Det. Dam	0870	27 N., 36 E., NENW 5
12. Hurricane Det. Res.	0871	27 N., 36 E., NENE 20
13. Moccasin Det. Res.	0872	27 N., 36 E., SESE 17
14. Beechnut Det. Res.	0874	28 N., 36 E., NESW 32
15. Mokee Det. Res.	0876	27 N., 35 E., SWSW 12
16. Alkali Det. Res.	0877	27 N., 36 E., SWNE 6
17. Tepee Det. Dam	0878	27 N., 36 E., NWNW 18
18. Badger Det. Dam	0879	27 N., 35 E., NENE 12
19. Judy Det. Dam	0895	27 N., 38 E., SWNE 21
20. January Det. Res.	0896	27 N., 38 E., NWSE 24
21. Deep Cut Det. Res.	0897	27 N., 38 E., SENE 22
22. Blanchard Det. Res.	0898	27 N., 39 E., SESW 30
23. Big Forks Det. Dam	0899	27 N., 38 E., NESE 34
24. TC Drop Dam	1073	26 N., 37 E., NENE 30
25. Jim Det. Dam	1085	26 N., 36 E., NENE 10
26. Gutshot Det. Dam	1086	26 N., 37 E., SWSE 34
27. Pearson Det. Dam	1087	25 N., 38 E., SWNW 4
28. Dog Creek Det. Res.	1097	26 N., 38 E., NENE 29
29. Bomber Det. Res.	1098	25 N., 38 E., SESE 15
30. Rinnie Det. Res.	1099	27 N., 36 E., SESW 33
31. Archambeault Det. Res.	1116	26 N., 39 E., NWSE 16
32. Skeeter Det. Dam	1118	25 N., 38 E., NWNE 12
33. Target Det. Dam	1119	25 N., 38 E., NWSE 11
34. Lori Det. Dam	1120	25 N., 38 E., NWNE 21
35. Gravel Hill Det. Res.	1121	25 N., 36 E., SWNW 14
36. Half Pint Det. Dam	1122	25 N., 36 E., NWSW 32
37. Corral Junction No. 1 Det. Res.	1125	25 N., 36 E., SWNE 24
38. Skull Det. Res.	1126	25 N., 37 E., SWNW 8
39. Your Name Det. Res.	1127	25 N., 37 E., SESE 9
40. Three Tree Det. Res.	1128	25 N., 37 E., SWNW 15
41. Cottonwood Det. Res.	1129	25 N., 37 E., NWSE 23
42. Corral Junction Det. Res.	1131	25 N., 37 E., SWNE 29
43. Corral Junction Ext. Det. Res.	1135	25 N., 36 E., NESW 24
44. Tin Roof Det. Res.	1136	25 N., 35 E., NWSW 12
45. One Fork Det. Res.	1137	25 N., 36 E., SENE 19
46. Hard Pan Det. Res.	1138	25 N., 36 E., NWNW 27
47. Sheepshed Det. Res.	1139	25 N., 35 E., SESE 26
48. Camp Det. Res.	1140	25 N., 36 E., NESE 33
49. Mudpot Det. Dam	1162	25 N., 37 E., SESW 31
50. Desert Det. Res.	1164	24 N., 36 E., SWSW 10
51. Short Creek Det. Res.	1166	25 N., 37 E., SENW 27
52. Upper S. Fork Det. Dam	1169	24 N., 36 E., NESE 7
53. Two Fork Det. Res.	1178	24 N., 37 E., NWSE 12
54. Chico Flats Det. Res.	1179	24 N., 38 E., NESW 6

TABLE 2.1: WILLOW CREEK WATERSHED STRUCTURES/SYSTEMS

Detention Structures	Number	Legal Location
55. Collins Det. Res.	1182	25 N., 37 E., SESE 24
56. Forest Det. Res.	1183	25 N., 37 E., SWSW 27
57. Half Barrel Det. Res.	1195	24 N., 37 E., SENW 4
58. Cactus Flat Det. Dam	1199	26 N., 38 E., SENW 24
59. Itcaina Det. Res.	1202	26 N., 37 E., SENW 9
60. South Beaver Det. Res.	1203	26 N., 37 E., NWSW 9
61. Script Det. Res.	1204	26 N., 37 E., SWNW 4
62. Arrambide Det. Res.	1205	26 N., 36½ E., NENE 1
63. Browning Det. Res.	1214	25 N., 38 E., NENW 29
64. Whitetail Det. Dam	1216	25 N., 36 E., NENW 5
65. Ruins Det. Dam	1218	25 N., 35 E., NENW 9
66. Fawn Drop Dam	1219	26 N., 35 E., SESE 15
67. Clover Drop Dam	1220	26 N., 35 E., SENE 9
68. Nod Det. Dam	1221	26 N., 35 E., SWSE 22
69. Bend Det. Dam	1222	26 N., 36 E., SWNW 18
70. Foulweather Det. Dam	1224	26 N., 35 E., SWSE 23
71. Hard Rock Det. Dam	1226	26 N., 35 E., SENW 24
72. SOB Det. Dam	1227	26 N., 35 E., SWNE 28
73. Horny Det. Dam	1228	26 N., 35 E., SWNE 27
74. ULT Det. Dam	1229	25 N., 35 E., SWNE 1
75. Double Crossing Det. Dam	1239	26 N., 36 E., SESW 23
76. Dead Horse Det. Dam	1240	26 N., 36 E., SWNW 14
77. Twin Forks Det. Dam	1241	26 N., 36 E., NENE 20
78. Triple Crossing Det. Res.	1242	26 N., 36 E., NESW 29
79. Finale Det. Dam	1326	25 N., 35 E., NWSE 9
80. Willow Flat Det. Dam	7262	26 N., 39 E., SWSW 21
81. Willow Creek Det. Res.	1080	26 N., 39 E., SWNE 29
82. Willow Flat Div. Res.	6879	26 N., 39 E., SWNW 29
83. Wagon Wheel Det. Res.		27 N., 36 E., SWSW 28
Water Spreading Dike Systems		
1. Burnett W.S.	0792 & 0793	27 N., 35 E., Secs. 25 & 30
2. Brazil Divide W.S.	0813	27 N., 36½ E., Sec. 1
3. Beaverette W.S.	0815	27 N., 37 E., NWNW 19
4. Lone Tree W.S.	0823	27 N., 36 E., SWSE 33
5. Archambeault W.S.	1102	26 N., 39 E., SWSW 21
6. Bomber W.S.	1103	25 N., 38 E., NESE 15
7. Cactus Flat W.S.	1200	26 N., 38 E., NESW 24
8. Triple Crossing W.S.	1259	26 N., 36 E., Secs. 29,21,
Triple Crossing W.S.	1260	22,23,24
Triple Crossing W.S.	1261	26 N., 36½ E., Sec. 24
Triple Crossing W.S.	1390	26 N., 37 E., Sec. 19
9. Dog Creek W.S.	1083	26 N., 38 E., Secs. 27,34,35

Source: BLM 1985

ALTERNATIVES CONSIDERED BUT NOT ANALYZED

This section presents several alternatives considered but rejected from further analysis for various reasons. These three alternatives were considered but not analyzed.

1. An alternative proposing watershed conservation programs (water control structures, land treatments, riparian habitat development) for the entire area of the basin was considered.

   There are land use planning documents and assorted staff reports recommending a complete watershed activity plan for the Willow Creek Basin. This means that upland treatments (i.e. grazing, mechanical, etc.) and further stream bank protection should be included. There are two reasons why an alternative of this type could not be analyzed.

   First, the complexity required through such an analysis would deter the planning process considerably. One must keep in mind that the basin size is 538 square miles and contains other forms of continuous activity planning. It is more advantageous for the Bureau of Land Management (BLM) to focus on large water control structures due to the varying opinions about their effectiveness.

   Secondly, there are ongoing activity plan implementations (Allotment Management Plans) where watershed objectives are recognized. These plans should continue to analyze and recommend upland treatments and necessary stream bank protection. Current activity planning in the area is associated with two recently written land use plans/environmental statements. To avoid conflicting activity planning, the decision was made to not write an all encompassing Willow Creek Activity Plan.

2. A zero cost alternative proposing complete abandonment without mitigations.

   Another alternative considered was one of total abandonment however, there would be no mitigations. This sort of an alternative would be a zero cost option. Politically and socially this idea is not practical. The BLM made a large investment in the area by implementing the original conservation plan. From that time forward the public and other resource agencies have relied on the BLM's program for aiding access, livestock watering, hunting, etc. in the area. Regardless of the effectiveness of the BLM's conservation program on the watershed resource, the Bureau must mitigate certain impacts where abandonment is proposed.

3. An alternative where new large water control projects are proposed.

   An alternative proposing new large water control structures/systems is not feasible at this time. There are currently two opposing lines of thought concerning the construction of water control structures. First, these systems are the root of much controversy within the field of watershed management. Some professionals feel that these structures/systems serve little purpose in an environment so naturally erosive. The problem eventually created by construction of a large reservoir may be as severe or worse than the initial problem. The reservoir, therefore, provides no long term solution to runoff control in watersheds (King, 1971).

   On the other hand, it is proven that flow detainment through the use of channel barriers is a way of reducing basin yields in sediment and runoff, and attenuating flood peaks. This fact is a well known principle, and is the basis for many flood control projects throughout the world. The need for channel controls is most often based on economic benefits.

   There are questions yet to be answered before new development should occur. Most of the hydrologic analysis presented in this document used a flood routing model with input derived through estimations and broad localized data. A better explanation of the hydrologic analysis follows in the next chapter, in the Watershed Section, and in Appendix 2.1A. To better understand the effects structures/systems have on runoff, input data must be calibrated using site specific data (i.e. measured storm events, reservoir spillway measurements). Once runoff regimes in the basin are better understood and the effects of structures/systems are clearly defined, this effectiveness must be compared with the often times high cost of installation and maintenance. Perhaps the effectiveness (or lack of) would dictate development of more upland treatments in a geologically erosive area such as Willow Creek. At this time the BLM needs to deal with the structures/systems in place and not risk further expenditures on new development.

ALTERNATIVE DESCRIPTIONS

This section describes the management alternatives analyzed by this EA. All the alternatives described follow these five assumptions:

(1) Short term construction period = 10 years;

(2) Long term implementation = 50 years;

(3) Plan implementation will begin 1986;

(4) The design life of structures/systems will last until at least 2035 (49 years from 1986), and later if original construction design determined such: and

(5) Fifteen percent of the cost of each alternative is for survey and design costs.

ALTERNATIVE NO. 1
NO ACTION
(CONTINUED MANAGEMENT)

Because of Council of Environmental Quality (CEQ) regulations, the BLM must consider a No Action Alternative. This would be defined as continued management at the present levels. In effect, this alternative would increase the present management level by placing an added emphasis on funding maintenance of these structures/systems.

Under this alternative all the structures/systems would be maintained to operate for at least 50 years. Priorities for maintenance work would be based on need for repair and emergency status. Engineering design would consider materials and techniques to achieve functioning structures/systems for the greatest extent of time, while needing the least additional maintenance (a more permanent structure/system). The total cost of this alternative is $2.59 million.

Maintenance construction is prescribed for those structures/systems with immediate needs, or those with design lives ending before 2035. Maintenance construction can consist of any one or all of the following: pipe replacement, slope protection, spillway repair, and cathodic protection. Refer to Appendix 2.2 for a more detailed description of these maintenance practices.

Table 2.2 shows the individual structure/system action proposals and related costs for Alternative 1 (and the other alternatives). These costs were estimated by reviewing a 1983 maintenance inventory report and the age of each individual structure/system. This method of estimation was especially difficult in those cases where a structure/system shows no immediate need, but has or is rapidly approaching the end of its design life. In these instances historical maintenance, on similar structures, was used for estimations (i.e., new pipe due to high corrosion problems).

This alternative proposes maintenance only and virtually no new designs. However, during implementation, site specific survey and design may indicate original design errors. This problem would dictate modifications in order to reduce risks. These modifications could increase or decrease the maintenance costs. This cost information would not be available until site specific survey and design work is done for individual structures.

By using the original design information and the implementation period of this plan, there is a 64% chance of one or more design storms occurring in the next 50 years above any one structure. (Most of these structures/systems were designed for a 50-year 6-hour storm event.) This is important to note, since even one event greater than the design event can cause severe damage to emergency spillways.

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST

Breakdown of Cost Estimates on Various Types of Actions

# 1.	Maintenance		
	Raise Pipe - typical 4'		
	Mobilization - $1,270.00		
	25,000 cu.yds. earthfill embankment @ $ 0.65	=	$16,250.00
	500 cu. yds. compacted earthfill @ $ 1.80	=	900.00
	44 lin. ft. - 36" wsp @ $1.45.00	=	6,380.00
	Salvage & replace guard rail	=	200.00
	Salvage & replace stone riprap	=	5,000.00
	Furnish & Install cathodic protector	=	1,000.00
			$31,000.00
# 2.	Maintenance		
	Anode Tube		
	4 - 48 lb. magnesium anodes @ $150.00	=	$ 600.00
	Load wire, straps & bolts		25.00
	Backhoe, 2 hrs. @ $50.00	=	100.00
	Laborer, 8 hrs. @ $12.00	=	96.00
	Backhoe Operator, 2 hrs. @ $16.00	=	32.00
	Mobilization		200.00
			$ 1,053.00
# 3.	Maintenance		
	Miscellaneous	Variable	
# 4.	Maintenance		
	Spreader dike reconstruction	Variable	
# 5.	Reroute Road		$108,000.00
# 6.	Pit Reservoir		
	Mobilization - $ 18.78		
	3,358 cu. yds @ $0.59 - 1,981.22		
	$2,000.00		
# 7.	Chisel Treatment		
	@ $18.00/acre		
# 8.	Chisel & Planting Treatment		
	@ $24.00/acre		
# 9.	Raise Inlet		
	$31,000/ea.		

#10.	Fence - 1 mile, 4-wire (4 braces, 1 gate, 1 corner)		
	Materials		
	312 Steel posts @ $2.50	$ 782.80	
	16 Treated posts @ $3.82	61.12	
	10 Brace posts @ $2.50	25.00	
	16 Spools wire @ $30.00	480.00	
	#9 smooth & misc.	20.00	
		$ 908.62	
	Labor		
	313 Rods @ $2.50	626.00	
	TOTAL	$ 1,994.62	per mile
#11.	Small Shallow Pond		
	Mobilization	$ 18.78	
	1,324 cu. yds @ $0.59	781.16	
		$ 799.94	
#12.	Islands		
	250 cu. yds. @ $0.65	$ 162.50	
	Mobilization	37.50	
		$ 200.00	

N/A - No Action

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST (Cont'd)

Structure/System	Alternative 1	Alternative 2	Alternative 3	Alternative 4
NOO Res.	N/A	N/A	1 Pit 2.0	N/A
TOTAL	0	0	$2,000	0
Bend Res.	#1 Maint. 42.6	N/A	#1 Maint. 42.6 4 Islands .8	#1 Maint. 41.6 4 Islands .8
TOTAL	$42,600	0	$43,400	$43,400
Foul Weather Res.	N/A	N/A	1 Pit 2.0	N/A
TOTAL	0	0	$2,000	0
Hardrock Res.	#1 Maint. 58.0	N/A	#1 Maint. 58.0 3 Islands .6 Raise Inlet 31.0	#1 Maint. 58.0 1 Pit 2.0
TOTAL	$58,000	0	$89,600	$60,000
SOB Res.	N/A	N/A	2 Islands .4	N/A
TOTAL	0	0	$400	0
Horny Res.	N/A	N/A	1 Pit 2.0	N/A
TOTAL	0	0	$2,000	0
Oouble Crossing Res.	#2 Maint. 1.0	N/A	#2 Maint. 1.0 11 Islands 2.2 Raise Inlet 31.0	N/A
TOTAL	$1,000	0	$34,200	0
Oead Horse	#2 Maint. 1.0	Reroute 108.0	#2 Maint. 1.0 4 Islands .8 Raise Inlet 31.0	Reroute 108.0
TOTAL	$1,000	$108,000	$32,800	$108,000
Twin Forks Res.	#2 Maint. 1.0	N/A	#2 Maint. 1.0 1 Pit 2.0 2 Islands .4 Raise Inlet 31.0	N/A
TOTAL	$1,000	0	$400	0
Triple Crossing Res.	N/A	N/A	Raise Inlet 118.0	N/A
TOTAL	0	0	$118,000	0
Finale Res.	N/A	N/A	Raise Inlet 31.0 2 Islands .4	N/A
TOTAL	0	0	$31,400	0
Willow Flat Res.	#1 Maint. 12.1	N/A	#1 Maint. 12.1 4 Islands .8 Raise Inlet 31.0	#1 Maint. 12.1
TOTAL	$12,100	0	$43,900	$12,100
Willow Creek Res.	#1 Maint. 13.5	N/A	#1 Maint. 13.5 4 Islands .8 Raise Inlet 31.0	#1 Maint. 13.5
TOTAL	$13,500	0	$45,300	$13,500
Willow Flat Oiv.	N/A	N/A	Raise Inlet 31.0 7 Islands 1.4	N/A
TOTAL	0	0	$32,400	0
Wagon Wheel Res.	#1 Maint. 2.5	N/A	1 Pit 2.0 7 Islands 1.4 #1 Maint. 2.5	N/A
TOTAL	$2,500	0	$5,900	0

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST (Cont'd)

Structure/System	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Chico Flats Res.	#3 Maint.	5.0	N/A		#3 Maint.	5.0	N/A	
	#1 Maint.	19.8			#1 Maint.	19.8		
					2 Islands	.4		
					Raise Inlet	31.0		
TOTAL		$24,800	0			$56,200		0
Collins Res.	#2 Maint.	1.0	N/A		#2 Maint.	1.0	#2 Maint.	1.0
TOTAL		$1,000	0			$1,000		$1,000
Forest Res.	#3 Maint.	5.0	N/A		1 Pit	2.0	#3 Maint.	5.0
	#2 Maint.	1.0			#3 Maint.	5.0	#2 Maint.	1.0
					#2 Maint.	1.0		
TOTAL		$6,000	0			$8,000		$6,000
Half Barrel Res.	#1 Maint.	25.2	N/A		#1 Maint.	25.2	#1 Maint.	25.2
					8 Islands	1.6	Raise Inlet	31.0
					Raise Inlet	31.0	8 Islands	1.6
TOTAL		$25,200	0			$57,800		$57,800
Cactus Flat Res.	#1 Maint.	25.7	N/A		#1 Maint.	25.7	#1 Maint.	25.7
					7 Islands	1.4		
					Raise Inlet	31.0		
TOTAL		$25,700	0			$58,100		$25,700
Itcaina Res.	#1 Maint.	18.9	Reroute	108.0	#1 Maint.	18.9	#1 Maint.	18.9
TOTAL		$18,900		$108,000		$18,900		$18,900
South Beaver Res.	#1 Maint.	35.6	N/A		#1 Maint.	35.6	#1 Maint.	35.6
					10 Islands	2.0		
					Raise Inlet	31.0		
TOTAL		$35,600	0			$68,600		$35,600
Script Res.	#1 Maint.	18.3	N/A		#1 Maint.	18.3	N/A	
					4 Islands	.8		
					Raise Inlet	31.0		
TOTAL		$18,300	0			$50,100		0
Arrambide Res.	#1 Maint.	35.9	N/A		#1 Maint.	35.9	#1 Maint.	35.9
					10 Islands	2.0		
					Raise Inlet	31.0		
TOTAL		$35,900	0			$68,900		$35,900
Browning Res.	#1 Maint.	39.9	N/A		#1 Maint.	39.9	#1 Maint.	39.9
					7 Islands	1.4		
					Raise Inlet	31.0		
TOTAL		$39,900	0			$72,300		$39,900
Whitetail Res.	N/A		N/A		Raise Inlet	31.0	N/A	
					3 Islands	.6		
					1 Pit	2.0		
TOTAL		0	0			$33,600		0
Ruins Res.	N/A		N/A		Raise Inlet	31.0	N/A	
					2 Islands	.4		
TOTAL		0	0			$31,400		0
Fawn Res.	#1 Maint.	28.5	N/A		#1 Maint.	28.5	N/A	
					1 Pit	2.0		
TOTAL		$28,500	0			$30,500		0
Clover Orop Res.	#3 Maint.	5.0	N/A		#1 Maint.	28.5	N/A	
	#1 Maint.	34.1			1 Pit	2.0		
TOTAL		$39,100	0			$70,700		0

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST (Cont'd)

Structure/System	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Pearson Res.	#1 Maint. 76.7	N/A	#1 Maint. 76.7 13 Islands 2.6 Raise Inlet 31.0	#1 Maint. 76.7
TOTAL	$76.7	0	$110,300	$76,700
Oog Creek Res.	N/A	N/A	Raise Inlet 31.0 5 Islands 1.0	N/A
TOTAL	0	0	$32,000	0
Bomber Res.	#1 Maint. 20.9	N/A	#1 Maint. 20.9 8 Islands 1.6 Raise Inlet 31.0	#1 Maint. 20.9
TOTAL	$20,900	0	$53,500	$20,900
Rinnie Res.	#1 Maint. 7.4	N/A	#1 Maint. 7.4 6 Islands 1.2 Raise Inlet 31.0	#1 Maint. 7.4
TOTAL	$7,400	0	$39,600	$7,400
Archambeault Res.	#1 Maint. 6.0	N/A	#1 Maint. 6.0 6 Islands 1.2 Raise Inlet 31.0	#1 Maint. 6.0
TOTAL	$6,000	0	$38,200	$6,000
Skeeter Res.	#3 Maint. 20.0 #1 Maint. 35.3	N/A	#3 Maint. 20.0 #1 Maint. 35.3 6 Islands 1.2 Raise Inlet 31.0	N/A
TOTAL	$55,300	0	$87,500	0
Target Res.	#2 Maint. 1.0	N/A	#2 Maint. 1.0 7 Islands 1.4 Raise Inlet 31.0	#2 Maint. 1.0
TOTAL	$1,000	0	$33,400	$1,000
Lori Res.	#2 Maint. 1.0	N/A	#2 Maint. 1.0 6 Islands 1.2 Raise Inlet 31.0	#2 Maint. 1.0
TOTAL	$1,000	0	$33,200	$1,000
Gravel Hill Res.	#3 Maint. 2.0	N/A	#3 Maint. 2.0 10 Islands 2.0 Raise Inlet 31.0	N/A
TOTAL	$2,000	0	$35,000	0
Half Pint Res.	#2 Maint. 1.0	N/A	#2 Maint. 1.0 8 Islands 1.6 Raise Inlet 31.0	N/A
TOTAL	$1,000	0	$33,600	0
Corral Jct. #1 Res.	N/A	N/A	Raise Inlet 31.0 9 Islands 1.8	N/A
TOTAL	0	0	$32,800	0
Skull Res.	#1 Maint. 37.5	N/A	#1 Maint. 37.5 5 Islands 1.0	N/A
TOTAL	$37,500	0	$38,500	0
Your Name Res.	#1 Maint. 9.8	N/A	#1 Maint. 9.8 4 Islands .8 Raise Inlet 31.0	N/A
TOTAL	$9,800	0	$41,600	0
Three Tree Res.	N/A	N/A	Raise Inlet 31.0 5 Islands 1.0	N/A
TOTAL	0	0	$32,000	0

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST

Structure/System	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Tomahawk Res.	#3 Maint. #2 Maint.	5.0 1.0	Reroute	108.0	#3 Maint. #2 Maint. 6 Islands Raise Inlet	5.0 1.0 1.2 31.0	Reroute	108.0
TOTAL		$6,000		$108,000		$38,200		$108,000
Grub Res.	#2 Maint.	1.0	Reroute	108.0	#2 Maint. Raise Inlet 21 Islands	1.0 31.0 4.2	#2 Maint. #3 Islands	1.0 .6
TOTAL		$1,000		$108,000		$36,200		$1,600
Upper Lone Tree Res.	#1 Maint.	18.3	N/A		#1 Maint. Raise Inlet 4 Islands	18.3 31.0 .8	#1 Maint.	18.3
TOTAL		$18,300	0			$50,000		$18,300
Brazil Divide Res.	#1 Maint.	17.0	1 Pit	2.0	Raise Inlet 4 Islands #1 Maint.	31.0 .8 17.0	1 pit	2.0
TOTAL		$17,000		$2,000		$48,800		$2,000
Beaverette Res.	#1 Maint.	16.5	1 Pit	2.0	#1 Maint. 5 Islands Raise Inlet	16.5 1.0 4.0	1 pit	2.0
TOTAL		$16,500		$2,000		$21,500		$2,000
NW Burrette Res.	#1 Maint.	15.0	N/A		Raise Inlet 6 Islands #1 Maint.	31.0 1.2 15.0	#1 Maint.	15.0
TOTAL		$15,000	0			$47,200		$15,000
Lower Burette H.C. Res.	#1 Maint.	20.0	N/A		#1 Maint. 7 Islands Raise Inlet	20.0 1.4 31.0	#1 Maint.	20.0
TOTAL		$20,000	0			$52,400		$20,000
SW Burette Res.	#3 Maint. #1 Maint.	5.0 9.3	N/A		#3 Maint. #1 Maint. 5 Islands Raise Inlet	5.0 9.3 1.0 31.0	#3 Maint. #1 Maint.	5.0 9.3
TOTAL		$14,300	0			$46,300		$14,300
Bugle Res.	#1 Maint.	5.0	N/A		#1 Maint. 2 Islands Raise Inlet	5.0 .4 31.0	N/A	
TOTAL		$5,000	0			$36,400	0	
Hamms Res.	#1 Maint.	40.7	N/A		#1 Maint. 8 Islands	40.7 1.6	#1 Maint. 1 Pit	40.7 2.0
TOTAL		$40,700	0			$73,300		$42,700
North Beaver Res.	#3 Maint. #1 Maint.	25.0 42.4	N/A		#3 Maint. #1 Maint. 10 Islands Raise Inlet	25.0 42.4 2.0 31.0	N/A	
TOTAL		$67,400	0			$100,400	0	
Hurricane Res.	#1 Maint.	34.0	1 Pit	2.0	#1 Maint. 3 Islands Raise Inlet	34.0 .6 31.0	#1 Maint. Raise Inlet 3 Islands	34.0 31.0 .6
TOTAL		$34,000		$2,000		$65,600		$65,600
Moccasin Res.	#3 Maint. #1 Maint.	25.0 30.4	N/A		#3 Main. #1 Main. 4 Islands Raise Inlet	25.0 30.4 .8 31.0	#3 Maint. #1 Maint.	25.0 30.4
TOTAL		$55,400	0			$87,200		$55,400

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST (Cont'd)

Structure/System	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Cottonwood Res.	#2 Maint.	1.0	N/A		#2 Maint.	1.0	#2 Maint.	1.0
					8 Islands	1.6	1 Mile Fence	2.0
					Raise Inlet	31.0		
TOTAL		$1,000	0			$33,600		$3,000
Corral Junction Res.	#2 Maint.	1.0	N/A		Raise Inlet	31.0	#2 Maint.	1.0
					1 Island	.2		
					#2 Maint.	1.0		
TOTAL		$1,000	0			$32,200		$1,000
Corral Jct. Ext. Res.	#1 Maint.	5.0	N/A		#1 Maint.	5.0	N/A	
	#2 Maint.	1.0			#2 Maint.	1.0		
					7 Islands	1.4		
					Raise Inlet	31.0		
TOTAL		$6,000	0			$38,400		0
Tin Roof Res.	#1 Maint.	20.0	N/A		#1 Maint.	20.0	N/A	
					3 Islands	.6		
					Raise Inlet	31.0		
TOTAL		$20,000	0			$51,600		0
One Fork Res.	#1 Maint.	25.0	N/A		#1 Maint.	25.0	#1 Maint.	25.0
					8 Islands	1.6		
					Raise Inlet	31.0		
TOTAL		$25,000	0			$57,600		$25,000
Hard Pan Res.	#2 Maint.	1.0	N/A		#2 Maint.	1.0	#2 Maint.	1.0
					12 Islands	2.4	4 Islands	.8
					Raise Inlet	31.0		
TOTAL		$1,000	0			$34,400		$1,800
Shepshed Res.	#1 Maint.	25.0	N/A		#1 Maint.	25.0	#1 Maint.	25.0
					5 Islands	1.0		
					Raise Inlet	31.0		
TOTAL		$25,000	0			$57,000		$25,000
Camp Res.	#1 Maint.	34.5	N/A		#1 Maint.	34.5	#1 Maint.	34.5
					6 Islands	1.2		
					Raise Inlet	31.0		
TOTAL		$34,500	0			$66,700		$34,500
Mudpot Res.	#3 Maint.	5.0	N/A		1 Pit	2.0	#3 Maint.	5.0
	#2 Maint.	1.0			#3 Maint.	5.0	#2 Maint.	1.0
					#2 Maint.	1.0		
TOTAL		$6,000	0			$8,000		$6,000
Oesert Res.	N/A		N/A		N/A		N/A	
TOTAL	0		0		0		0	
Short Creek Res.	#1 Maint.	57.0	N/A		#1 Maint.	57.0	N/A	
					8 Islands	1.6		
					Raise Inlet	31.0		
TOTAL		$57,000	0			$89,600		0
Upper S. Fork Res.	#1 Maint.	21.5	1 Pit	2.0	#1 Maint.	21.5	#1 Maint.	21.5
					2 Islands	.4	Raise Inlet	31.0
					Raise Inlet	31.0	2 Islands	.4
							1 Pit	2.0
TOTAL		$21,500		$2,000		$52,900		$54,900
Two Forks Res.	#3 Maint.	2.0	N/A		#3 Maint.	2.0	#3 Maint.	2.0
	#1 Maint.	32.0			#1 Maint.	32.0	#1 Maint.	32.0
TOTAL		$34,000	0			$34,000		$34,000

Table 2.2: WILLOW CREEK PROJECTS BY ALTERNATIVE ACTION & TOTAL COST (Cont'd)

Structure/System	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Beechnut Res.	#1 Maint.	14.2	N/A		#1 Main.	14.2	N/A	
					3 Islands	.6		
					Raise Inlet	31.0		
TOTAL		$14,200	0			$45,800	0	
Mokee Res.	#1 Maint.	9.4	N/A		#1 Maint.	9.4	N/A	
					4 Islands	.8		
					Raise Inlet	31.0		
TOTAL		$9,400	0			$41,200	0	
Alkali Res.	#1 Maint.	30.9	N/A		#1 Maint.	30.9	#1 Maint.	30.9
					6 Islands	1.2		
					Raise Inlet	31.0		
TOTAL		$30,900	0			$63,100		$30,900
Tepee Res.	#1 Maint.	18.1	N/A		#1 Maint.	18.1	N/A	
					4 Islands	.8		
					Raise Inlet	31.0		
TOTAL		$18,100	0			$49,900	0	
Badger Res.	#1 Maint.	23.9	N/A		#1 Maint.	23.9	#1 Maint.	23.9
					5 Islands	1.0	Raise Inlet	31.0
					Raise Inlet	31.0	5 Islands	1.0
TOTAL		$23,900	0			$55,900		$55,900
Judy Res.	#2 Maint.	1.0	Reroute	108.0	#2 Maint.	1.0		108.0
					6 Islands	1.2		
					Raise Inlet	31.0		
TOTAL		$1,000		$108,000		$33,200		$108,000
January Res.	#1 Maint.	55.2	Reroute	108.0	#1 Maint.	55.2	#1 Maint.	55.2
					4 Islands	.8	Raise Inlet	31.0
					Raise Inlet	31.0	4 Islands	.8
TOTAL		$55,200		$108,000		$87,000		$87,000
Oeep Cut Res.	#1 Maint.	38.1	Reroute	108.0	#1 Maint.	38.1	#1 Maint.	38.1
					1 Pit	2.0	2 Islands	.4
					2 Islands	.4		
TOTAL		$38,100		$108,000		$40,500		$38,500
Blanchard Res.	#2 Maint.	1.0	N/A		#2 Maint.	1.0	#2 Maint.	1.0
	#3 Maint.	5.0			1 Island	1.4		
					Raise Inlet	31.0		
TOTAL		$6,000	0			$38,400		$6,000
Big Forks Res.	#1 Maint.	38.3	N/A		#1 Maint.	38.3	#1 Maint.	38.3
					7 Islands	1.4		
					Raise Inlet	31.0		
TOTAL		$38,300	0			$70,700		$38,300
Triple Crossing Orop Res.	#2 Maint.	1.0	N/A		#1 Maint.	1.0	#2 Maint.	1.0
					2 Islands	.4	2 Islands	.4
TOTAL		$1,000	0			$1,400		$1,400
Jim Res.	#2 Maint.	1.0	N/A		#2 Maint.	1.0	#2 Maint.	1.0
					16 Islands	3.2	9 Islands	1.8
					Raise Inlet	31.0		
TOTAL		$1,000	0			$35,200		$2,800
Gutshot Res.	#3 Maint.	2.0	N/A		#2 Maint.	1.0	#3 Maint.	2.0
	#2 Maint.	1.0			#3 Maint.	2.0	#2 Maint.	1.0
					13 Islands	2.6		
					Raise Inlet	31.0		
TOTAL		$3,000	0			$36,600		$3,000

ALTERNATIVE 2 ABANDONMENT (THE PROPOSED ALTERNATIVE)

With this alternative no further maintenance or improvement would be applied to any structure/system. The only costs of implementing this alternative are those associated with resource mitigations. The types of mitigations considered with this alternative are revegetation, livestock watering facility relocation and road reroutes and are further detailed in Appendix 2.3 and Chapter 4. The total cost of this alternative would be $1.04 million. Table 2.2 shows the individual structure/system proposals and related costs for this alternative.

Time and storm occurrence would be the implementation agents with this alternative. Normal deterioration, pipe corrosion, wave action and significant flood events would cause failure randomly throughout the period of the plan.

The risks of various structures/systems failing would be maximized under this alternative. The management prescription of this alternative is to not maintain or improve any structure/system; consequently risking its failure. Refer to Chapters 3 and 4 for an explanation of risks associated with the entire basin and the collective impacts of abandoning all structures/systems.

ALTERNATIVE NO. 3 RECONSTRUCTION AND MAJOR ENHANCEMENT

Selection of this alternative would mean that all structures would at least be maintained and many would be modified if multiple resource values could be improved or enhanced. Enhancement is based on the individual structure/system value ratings and respective potentials. Maintenance would be identical to that described in Appendix 2.2. The total cost of this alternative is $5.89 million. Table 2.2 shows the individual structure/system proposals and related costs for this alternative.

These costs were estimated by using the maintenance costs shown in Table 2.2 for Alternative 1, and adding those costs to the costs of the modifications proposed. All modification costs were categorized according to types of construction — as shown at the conclusion of Table 2.2. The cost of this alternative includes continuing the BLM—US Geological Survey Interagency Flood Routing Study for 10 years. This study information would be used to refine the model and guide the maintenance and modification work on the various structures. It would cost $21,000 per year with this alternative for a hydrologist and an engineer to analyze the study information, and determine the most cost effective maintenance and modification methods to utilize.

Combined with maintenance, most of the structures/systems would be modified by increasing water storage capacity (by raising pipe, dam or spillway), developing earthen islands development, constructing small wildlife ponds and/or developing livestock watering pits (see Appendix 2.4).

Individual structure/system risks should be considered where water storage modifications are proposed. The survey and design of all structures/systems would include a risk analysis described in BLM Technical Note 337, Hydrologic Risk and Return Period Selection for Water Related Projects. This analysis would be possible since nearly all structures/systems would be redesigned according to their modification proposals.

ALTERNATIVE NO. 4 PRIORITIZED STRUCTURE/ SYSTEM MANAGEMENT

The structures/systems identified as "key" or "higher value" watershed protection devices would at least be maintained with this alternative. There are 35 reservoirs and 4 systems identified as having insignificant watershed value. This alternative proposes abandoning these 39 structures/systems. Those remaining structures/systems (48 reservoirs and 5 systems) would be recommended for maintenance and modification based on priority and careful consideration of resource values.

If abandoned reservoirs or water spreading systems are high in access or livestock watering values, these impacts would be mitigated. The mitigation costs are part of the total alternative cost. Maintenance as would again consider engineering design to include materials and techniques to achieve functioning structures/systems for the greatest extent of time and the least additional maintenance. The total cost of this alternative is $2.71 million. Table 2.2 shows the individual structure/system proposals and related costs for this alternative. The cost of this alternative includes continuing the BLM—US Geological Survey Interagency Flood Routing Study for 10 years. This study information would be used to refine the model and guide the maintenance and modification work on the various structures. It would cost $14,000 per year with this alternative for a hydrologist and an engineer to analyze the study information and determine the most cost effective maintenance and modification methods to utilize.

With the exception of an additional type of modification, all proposed modifications are identical to those described in Appendix 2.4. Engineering feasibilities and designs would remain the same. A fenced cattle exclosure would be constructed immediately downstream from Cottonwood Reservoir. One mile of constructed fence is needed to complete this exclosure.

Mitigative actions for abandoned reservoirs include development of livestock water pits, increased reservoir storage by raising pipes, spillways or dams, access road reroutes, and mechanical treatments with seeding adjacent to or within dike systems. These types of developments are described in Appendix 2.3.

For structures/systems where improper original designs are identified or storage modifications are proposed, a risk analysis would be performed. The analysis would dictate the new structure system design. Refer to Alternative 3 for the specific methodology to be used during survey and design of structures/systems.

ALTERNATIVE SUMMARY

The following table summarizes the changes expected with each alternative. Chapter 4, Environmental Impacts, contains specific information regarding the effects of each alternative.

TABLE 2.3: SUMMARY OF ALTERNATIVES

Environmental Component	Existing Situation	Alternative 1 Short Term	Alternative 1 Long Term	Alternative 2 Short Term	Alternative 2 Long Term	Alternative 3 Short Term	Alternative 3 Long Term	Alternative 4 Short Term	Alternative 4 Long Term
WATERSHED									
Flood peak from 100 year storm in CFS	4,710	--	4,710	--	22,400	--	4,710	--	5,080
Potential acreage flooded in conference area	ZD	--	ZD	--	2,192	--	ZD	--	ZD
Sediment storage in tons/year for _____ years	307,474 18 years	--	307,474 18 years	--	307,474 10 years	--	571,194 33 years	--	230,688 20 years
VEGETATION									
Pounds of herbage produced in impacted area (spreader system)	2,328,000	--	2,328,000	--	776,000	--	2,328,000	--	1,685,600
GRAZING MANAGEMENT									
Structure System									
Value to livestock									
Season long stock water	12	--	12	--	5	--	83	--	13
Stock water until mid July	14	--	14	--	5	--			12
Stock water only during spring runoff or none	57	--	57	--	73	--			58
WILDLIFE									
Structure/system									
Value to wildlife									
High	5	--	5	--	0	--	31	--	6
Medium	22	--	22	--	0	--	54	--	19
Low	65	--	65	--	92	--	7	--	67
Population change by alternatives									
Big game		0	0	0	10% dec.	0	20% Inc.	0	0
Upland gamebird		0	0	0	20% dec.	0	30% Inc.	0	0
Waterfowl		0	0	0	70% dec.	50% Inc.	100% Inc.	5% Inc.	20% Inc.
Riparian habitat		0	0	0	Mod. dec.	Slg. Inc.	Maj. Inc.	Slg. Inc.	Mod. Inc.
Fisheries		0	0	0	0	0	0	0	0
T & E		0	0	0	0	0	0	0	0
ECONOMIC CONDITIONS									
Benefits in present values									
Flood control		--	80,000	--	61,000	--	80,000	--	80,000
Sediment reduction		--	22,000	--	0	--	51,000	--	9,000
Recreation		--	98,000	--	75,000	--	139,000	--	101,000
Total Benefits in present values		--	$200,000	--	$136,000	--	$270,000	--	$190,000
Costs in present values		--	1.618 Mil.	--	.651 Mil.	--	3.683 Mil.	--	1.697 Mil.
Benefit/cost ratio		--	0.12/1	--	0.21/1	--	0.07/1	--	0.11/1
Total Cost		--	2.59 Mil.	--	1.040 Mil.	--	5.89 Mil.	--	2.71 Mil.
Employment (Valley County)	4,593	+9	--	+4	--	+21	--	+9	--
Earnings ($)(Valley County)	52,400,000	+150,000	--	+60,000	--	+332,000	--	+149,000	--
RECREATION									
Big game	1,300 RVD	N/C	N/C	N/C	-130 RVD	N/C	+270 RVD	N/C	N/C
Upland game	200 RVD	N/C	N/C	N/C	- 40 RVD	N/C	+ 60 RVD	N/C	N/C
Waterfowl	160 RVD	N/C	N/C	N/C	-110 RVD	N/C	+160 RVD	N/C	+30 RVD

-- - Indicates no change or impact or that accurate changes cannot be calculated
ZD - Zero damage - none of the acreage flooded would be damaged
dec. - Decrease
Mod. Dec. - Moderate decrease
Inc. - Increase
Slg. Inc. - Slight increase
Mod. Inc. - Moderate increase
Maj. Inc. - Major increase
Mil. - Million
N/C - No change

3

THE AFFECTED ENVIRONMENT

INTRODUCTION

This chapter discusses the various physical, biological and socio economic characteristics in the area that may be impacted by any of the alternatives. Only those resource components that may be impacted are discussed.

This chapter also considers the various structures/systems, resulting from the management objectives outlined in Chapter 1, as part of the physical environment.

CLIMATE AND AIR QUALITY

The climate of the Willow Creek Basin is semi-arid continental. A large percentage of its precipitation occurs from May through August. Yearly temperatures vary greatly with extremely cold winters (-38 degrees Fahrenheit) and warm to hot summers (109 degrees Fahrenheit). Winds are primarily out of the west.

Table 3.1 summarizes climatic data collected at Glasgow, located approximately 6 miles north of the Willow Creek U.S. Geological Survey (USGS) gauging station and at Fort Peck located approximately 9 miles east of Willow Creek USGS gauging station. Figure 3.1 presents the average monthly precipitation recorded in Glasgow from 1955 through 1976 and in Fort Peck from 1934 through 1976.

Storms which occur April through June are often long duration, low intensity rain events. Runoff from these storms can be dramatic, especially when there is a late spring snowpack. Although winter snowstorms contribute only 34% of the average annual precipitation total, the rapid increases in temperature, dark gray soils, and early spring rains cause snowmelt periods to be short with high runoff peaks.

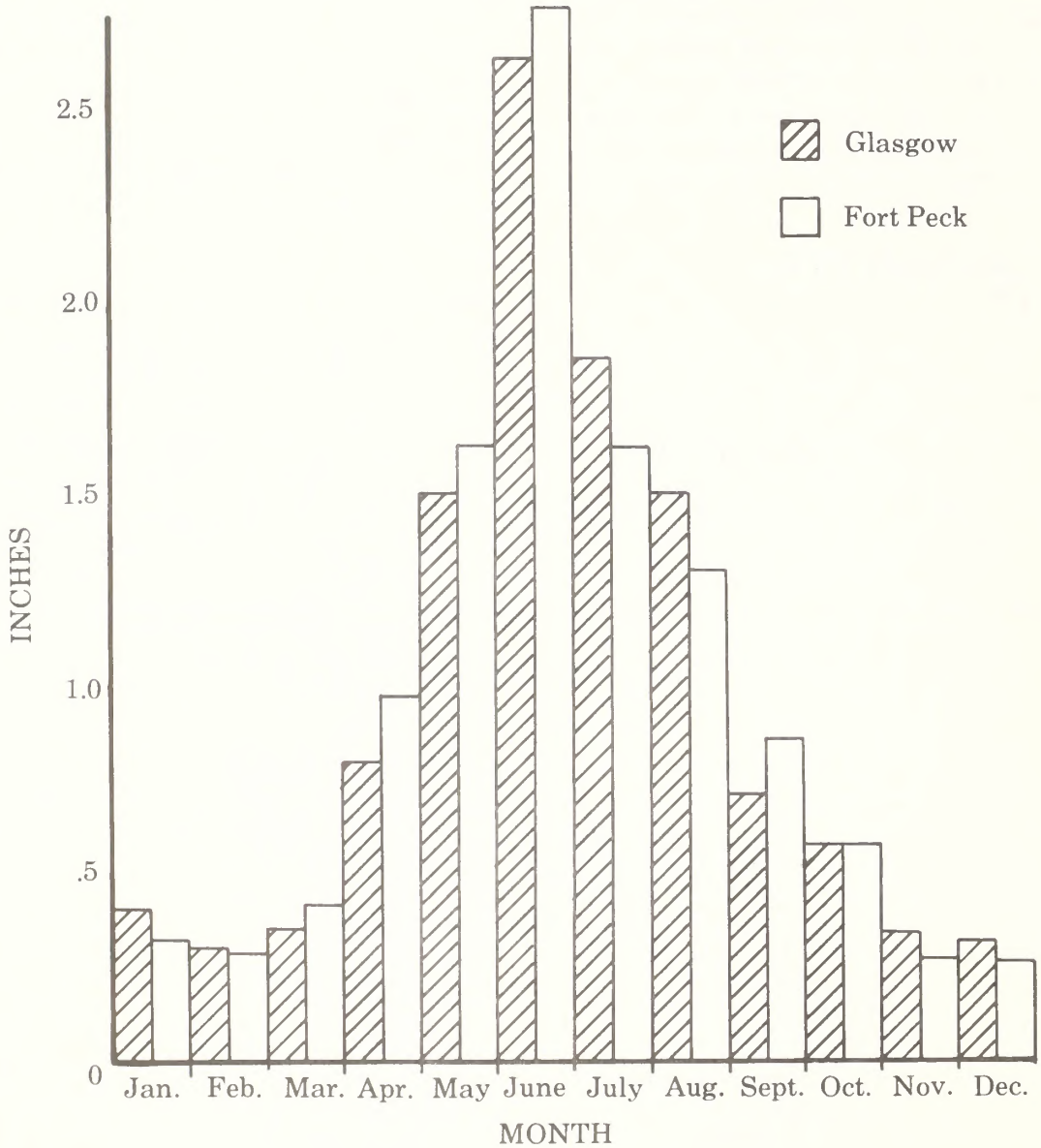
TABLE 3.1 CLIMATIC DATA SUMMARY

	Glasgow	Ft. Peck
Years of Record	21	42
Average Annual Precip. (inches)	11.14	11.34
Average Precip. for Period of April-June (inches)	4.90	5.32
Average Precip. for Period July-August (inches)	3.30	2.99
Average Mean January Temperature (° F)	9.51	11.71
Average Mean August Temperature (° F)	69.76	70.26
Average Total Snowfall	27.20	19.61

Source: NOAA Station Historical List.

Thunderstorms occurring in July and August are often very intense. This type of isolated, convective storm has been responsible for most of the flood occurrence and related damage to both structures/systems and downstream areas (north of the planning area). Some examples of storms which produced flood magnitudes large enough to cause damage include: July 23, 1962 — 4.01 inches in 24 hours (Glasgow Airport); July 16, 1969 — 5.00 inches in 12 hours (rancher); June 20, 1974 — 5.00 inches in 12 hours (Fort Peck). The USGS estimated 66% of the precipitation gauged in the basin during 1958-67 occurred in response to summer rainstorms (Frickel, 1972).

FIGURE 3.1 WILLOW CREEK AREA AVERAGE MONTHLY PRECIPITATION



SOURCE: NOAA Station Historical List.

The temperature span between maximum and minimum daily temperatures averages about 23 degrees Fahrenheit. Daily temperature changes can be large and occur within 3 to 6 hours causing rapid snowmelt under certain conditions. The average annual pan evaporation for the area varies from 40 to 42 inches.

Air quality in the Willow Creek area is good with most of the basin maintaining Class II air quality standards. No industrial sources of air contaminants lie within or adjacent to the area. Dust is blown about from roads and other areas where bare soil is exposed and pollen and spores from vegetation are seasonal additions to suspended particulate matter.

TOPOGRAPHY

The Willow Creek drainage is composed of three major creeks. The northwest portion drains into Lone Tree Creek and the northeast portion drains into Little Beaver Creek. Both of these creeks flow southeast to join Willow Creek.

Sub-watersheds in the basin trend northwest/southeast forming a gentle hilly terrain in the northern portion and a steeper badland terrain south of Willow Creek. The southern rim of the basin borders the Missouri Breaks, elsewhere it's bordered by other tributaries of the Milk River. The trend of the Willow Creek channel contrasts sharply to the dominate drainage trend within the basin.

Similar characteristics are found within each of the three major creeks. Rimrock in the south and weathered outcrops along ridges have slopes in excess of 50%. Hilly uplands with shallow clay soils have slopes of less than 35%. Flats and coulee bottoms composed of clay hardpan with silty clay and alkaline soils have slopes of less than 5%. The three creek bottoms are deeply incised and meander through the flats, eventually connecting with the Milk River south of Glasgow.

GEOLOGY

The distinct geology of Willow Creek is described best by its stratigraphy, lithology and history. The discussion of stratigraphy will be limited to formations which are exposed within the basin. The lithologic description will be limited to the Bearpaw shale. A brief geologic history will concentrate on the genesis of Willow Creek.

The oldest formation, exposed throughout the Willow Creek Basin, is the Bearpaw shale. It has an average thickness of 1,140 feet. The shale grades upward into the Fox Hills sandstone. The thickness of the sandstone varies between 35-145 feet, due to an erosional period before glacial deposition. The upper beds are highly resistant and form rimrock ridges along the southern rim of the Willow Creek Basin. A southern sloping mantle of glacial till between 5-20 feet thick lies north of the Milk River. Between the Milk and the Missouri Rivers, it is attenuated, leaving only small erratic deposits. Soils and alluvium within the basin are derived from the Bearpaw shale.

The Bearpaw formation consists of dark gray clayey shale with bentonite found both in beds and disseminated through much of the shale. Where bentonite is absent, the shale weathers into small, soft chips. The chips are easily removed by sheetwash but may form a weathered zone several tens of feet thick when undisturbed by erosional forces. Where bentonite is present, the shale weathers into a hard, foot thick rind. The rind swells when wet and shrinks when dry, forming abundant shallow cracks and a smaller number of deeper cracks. The deeper cracks allow appreciable channel slumping and headcutting during runoff. The prevalance of bentonite and other clay minerals in the formation also creates a high runoff environment.

Pleistocene glaciation played a major role in the Willow Creek Basin. The ancient Willow Creek flowed east, joining the Missouri River below the present day Fort Peck Dam. Advancing from the north, a regional ice sheet was divided into lobes which were redirected west. One lobe moved up the Milk and another moved up the Missouri, each forming ice dams and backing up water along the way. It has been suggested that at this point the divide between the Milk River and Willow Creek was submerged by backwater from the Milk, eroding a spillway through the soft Bearpaw shale. Meanwhile the Missouri River ice lobe dammed the ancient Willow Creek channel, causing the water backed from Willow Creek to eventually find the new spillway draining into the Milk. As the Milk River ice lobe receded, Willow Creek established itself in this now steeper valley. While many small drainages shifted course within their valleys, Willow Creek remains alone in undergoing a drastic directional shift.

Another geologic phenomenom was responsible for the deep incision of Willow Creek and its tributaries. While the ice regressed, the river bottoms of the Milk and the Missouri gradually aggraded. The effect was felt far up the principal tributaries such as Willow Creek. Wide alluvial terraces were built up in the Willow Creek valley bottoms as the river beds continued building. In recent geologic time, the down-cutting regime has resumed and has since lowered the floodplain about 25 feet. Again the effect was felt in the tributaries and Willow Creek began cutting channels through the alluvial terraces.

Some other tributaries of the Milk and the Missouri possess similar geologic traits, but none have the same combination of soils and relief generated by Willow Creek's unique history. Willow Creek may exemplify maximum erosive force in eastern Montana.

A review of the available information indicates that 272 archaeological sites have been recorded in the Willow Creek area. As is typical of the glaciated portion of Montana, over half (167) are tipi ring sites. Stone piles or cairns were the next most frequent type of site, represented by 59 occurrences. The remaining sites can be described as rock alignments that were recorded 18 times, hearths or other occupation sites that were recorded 12 times, lithic scatters that were recorded 10 times, sites that were combinations of tipi rings and other features were recorded 4 times, sites that were faunal remains were recorded 2 times, and 1 historic site.

Paleontological resources are also known from the study area. These specimens have come from the Cretaceous Age Bearpaw shales and include unique invertebrates as well as reptile species like the mosasaur.

CULTURAL RESOURCES

The Lewistown District Class I inventories (Ruebelmann, 1983; Okey, 1981) for history and prehistory, adequately address the overall historic and prehistoric setting for the Willow Creek area. These inventories discuss the major work done there, the types of sites to be expected in the area and its potential for significant cultural resources.

Information more specific to Willow Creek is available in the Reserved Natural and Cultural Heritage Resources in the Brazil/Little Beaver Creek's Bentonite Mining Claim Area, (Davis and Aaberg, 1976). This report deals with the result of surveying 20,400 acres, most of which fall into the present study area and discusses the cultural resource problems and potential of the area. It also introduces a new site type, "rock clusters," that may or may not serve the same function as a tipi ring. On the question of the time range of human use of the area, Davis and Aaberg make the following statement:

> "It was probable that most sites in the study area reflect land use during the Late Prehistoric Period. Physical evidence of earlier prehistoric use, particularily in the form of characteristic artifacts was removed prior to the survey by collectors."
>
> (*Davis and Aaberg, 47; 1976*)

WATERSHED

SOILS

The soils of the Willow Creek Basin can be divided into three main groups, with each group reflecting the characteristics of their parent formation.

The first group is the nearly level and gently sloping, deep, well-drained soils of the floodplains, fans and low terraces. These alluvial soils, derived primarily from the Bearpaw shale, are silty clay and clay textured and are relatively impermeable. A significant feature of these soils is the development of hardpan "slicks" and "semislicks."

The second group is the nearly level to hilly, shallow to moderately deep, well-drained soils of the shale uplands. These soils are composed basically of weathered Bearpaw shale. Various amounts of coarser materials, which are usually remnants of glacial material, are evident in some areas. There are considerable areas of barren shale outcrop on the hills and ridges in this landscape.

The third group is deep to shallow, gently sloping to hilly, well-drained loam and sandy loam soils formed in materials weathered from sandstone and alluvium. Minor inclusions of sandstone outcrops and soils formed in glacial till are part of this group.

Figure 3.2 is a soil hydrologic map showing the extent of these soils and the hydrologic curve number for each soil group. This figure also gives a list of the soil mapping units in each of the three soil groups. The curve numbers were developed using range site, soil characteristics and ground cover for soil series in the Willow Creek Basin (Hanson, 1981). Appendix 3.1 is an explanation of the physical properties of the soils in the Willow Creek Basin.

The inherent characteristics of the soils and vegetation of this basin are the major factors responsible for the watershed problems.

Approximately 90 to 95% of the basin consists of soils from groups 1 and 2 described previously. These shale derived soils have high percentages of clay (up to 65%), high sodium content (SAR up to 16) and low percentages of organic matter. These characteristics create slow infiltration and permeability and coupled with sparse to no ground cover lead to runoff and sediment yield rates that are high. These soils are in the Soil Conservation Service (SCS) hydrologic group D and have hydrologic curve numbers of 83 to 88.

These high erosion and sediment yields are evidenced by the natural gully and rill erosion occurring on the sparsely vegetated shale uplands, by the alluvial fans riddled by gullies and headcuts and by the channel bank instability along Willow Creek and its tributaries.

RUNOFF

All of the tributaries to Willow Creek are ephemeral. Willow Creek and the lower reaches of Lone Tree and Little Beaver Creeks will flow for extended periods following storm events. Runoff in the basin is generated primarily by rainfall excess. Some winter and spring runoff events can contribute additional flows from snowmelt. As explained earlier in this chapter the soils and geology of the area cause high runoff rates.

The U.S. Geological Survey (USGS) established a recording stream gauge at the mouth of the watershed in 1953. This gauge has operated continuously for the last 31 years. During the period, 1954 to 1968, the USGS conducted watershed studies throughout the Willow Creek drainage. Their data analysis and conclusions were documented in Hydrology and Effects of Conservation Structures, Willow Creek Basin Valley County, Montana, by Donald G. Frickel, 1972. Recently, the Bureau of Land Management (BLM) and USGS initiated a flood routing cooperative study, where data is collected using several recording precipitation and stream/reservoir stage gauges. The objective of this current study is to calibrate a selected flood routing model using compiled data from the basin.

The annual average discharge for Willow Creek since 1953 is 57.3 cubic feet per second (cfs) or 41,510 acre-feet/year. It is noted in the USGS Water Resources Data publications that records from the recording gauge are poor due to the impacts the structures/systems and other retention dams have on natural discharges from the basin. The average annual runoff from upland areas is varied and has been estimated to range from 0.08 acre-feet/acre on upland benches and foot slopes, to 0.30 acre-feet/acre on steep slopes consisting mainly of geologic outcrops and acid shale-derived soils. Willow Creek experiences no flow at certain times every year. Figure 3.3 shows average monthly discharge at the Willow Creek USGS gauge.

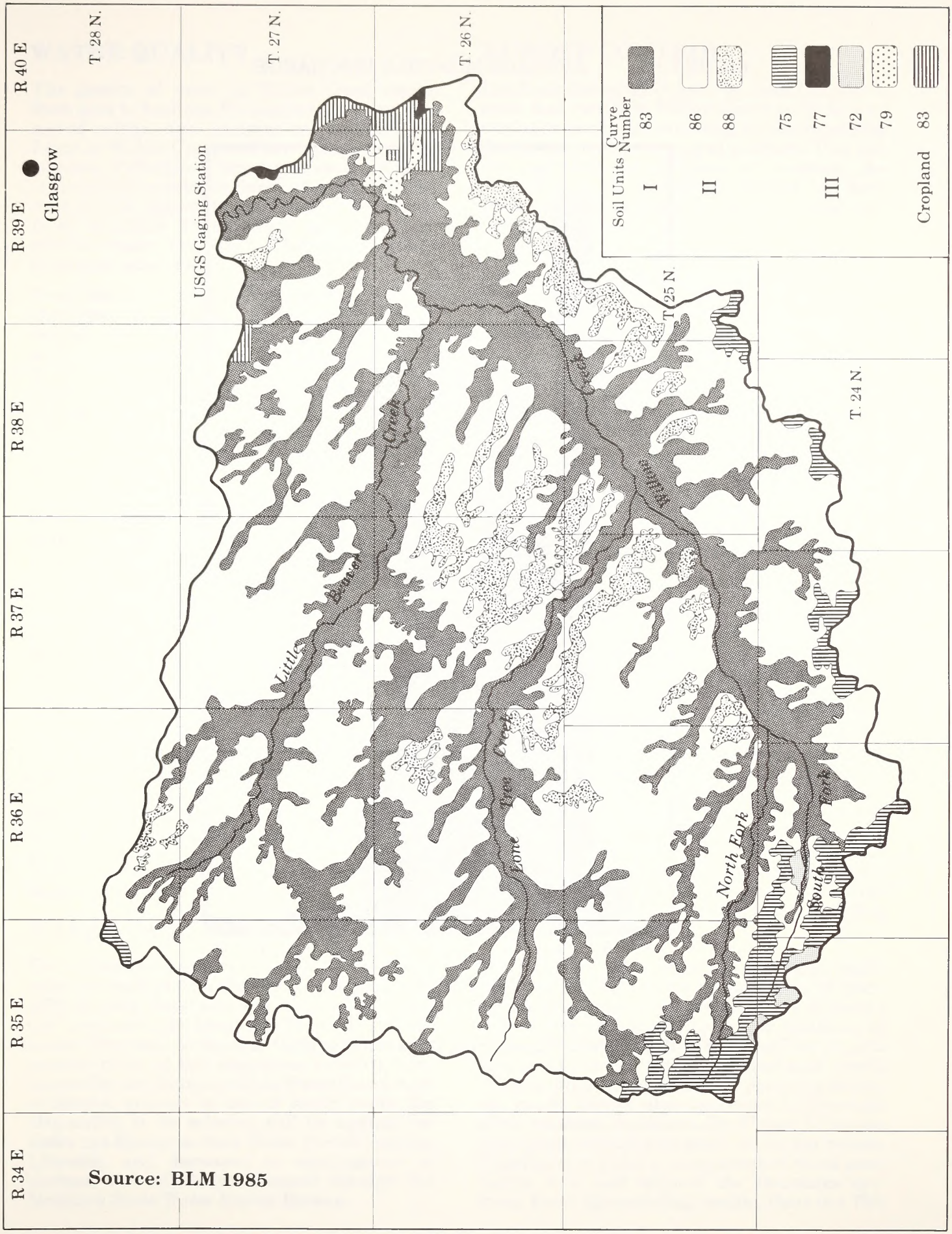
Severe flooding caused by storm events occurring in spring and summer was one of several principal reasons for implementing the original conservation project. Immediately prior to initial construction of the structures/systems one of the largest floods ever documented in the lower Milk River Basin occurred during April, 1952. Photographs, taken of the Milk River/Willow Creek confluence during this event, show Willow Creek flows being extremely large. Flooding in the downstream Milk River/Willow Creek confluence area is discussed in the Runoff Control section. Since the structures have been in place, two extreme discharges have been recorded at the USGS gauge on July 14, 1962, and June 21, 1974. There have been at least five floods where BLM conservation structures have incurred severe damage.

FIGURE 3.2 SOIL MAPPING UNITS & HYDROLOGIC CURVE NUMBER THAT OCCUR IN THREE SOIL GROUPS

Group 1				
	CN 83	1B	Ustic Torrifluvents	0-2% slopes
		34B	Elloam clayloam	1-5%
		51B	Phillips loam	0-5%
		152B	Absher-Vaeda Complex	0-5%*
		504	Harlem clay, wet	0-2%
Group 2				
	CN 86	48E	Dilts-Julin-Neldore Complex	5-35% slopes
		148E	Dilts-Neldore-Rock outcrop, Shale Complex	9-35%
		149D	Thebo-Dilts Complex	2-15%
		249D	Sunburst-Dilts-Neldore Complex	9-35%
	CN 88	100E	Shale-Dilts Complex	9-35%
Group 3				
	CN 75	41E	Cabbart-Delpoint Complex	9-35% slopes
	CN 77	37B	Marias clay	1-9%
	CN 72	551B	Phillips-Scobey Complex	2-9%
	CN 79	3E	Sunburst Clayloam	9-35%

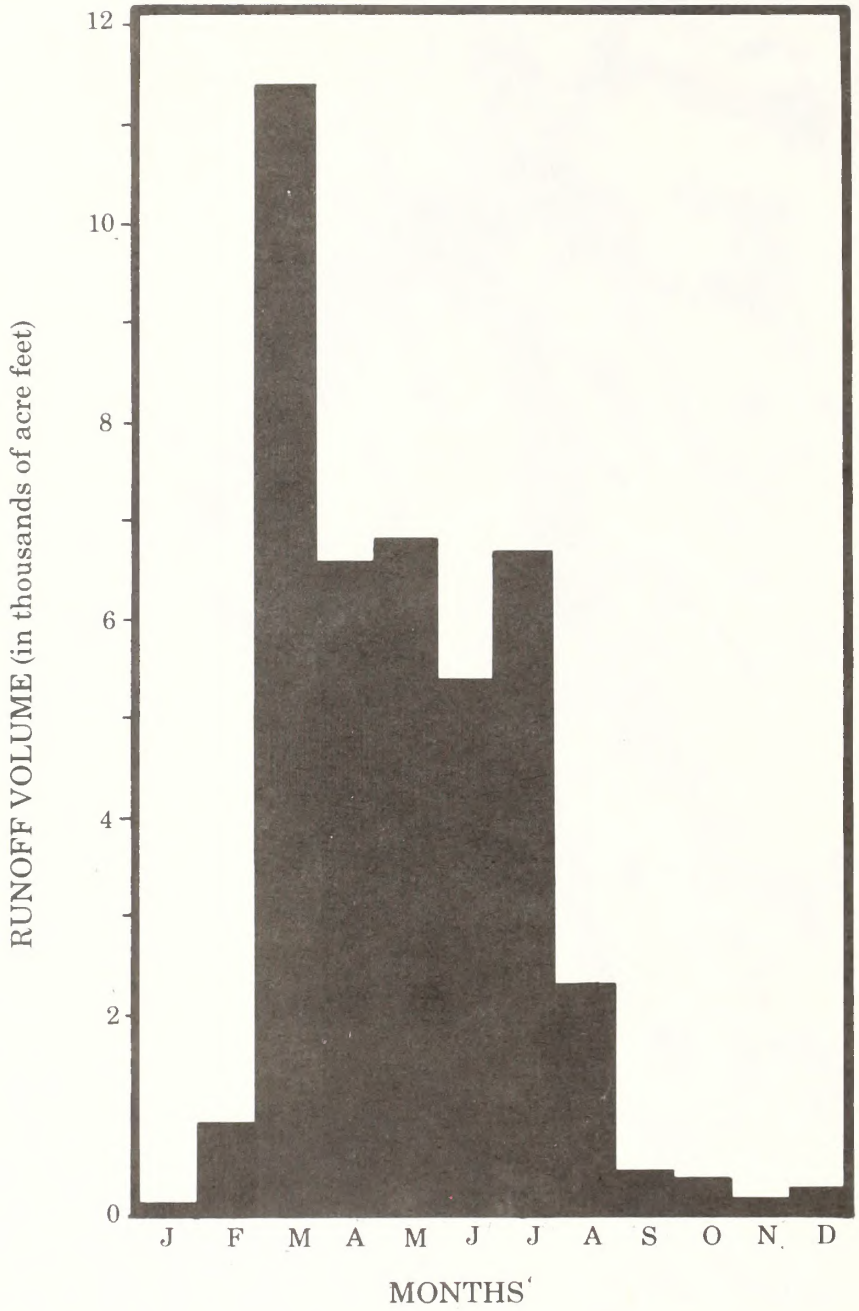
*This mapping unit is by far most dominant in Group 1.

FIGURE 3.2 (Cont.)



Source: BLM 1985

FIGURE 3.3 AVERAGE MONTHLY DISCHARGE



SOURCE: USGS Willow Creek Gage — 1954-1967

WATER QUALITY

The quality of water in Willow Creek varies from poor to medium. Suspended sediment, dissolved solids, and bacteria are constituents found in Willow Creek and are typical of prairie streams. Pollution occurs from non-point sources primarily related to livestock grazing. In its Annual 208 Report to the State of Montana, BLM identified Willow Creek as a non-point problem basin, with the problem being mainly of natural phenomena.

Total dissolved solid concentrations and conductivities in streams and reservoirs usually exceed 200 milligram/liter (mg/l) and 300 umhos, respectively. Stream pHs range from 6.0 to 7.5. Chemical quality of the water in Willow Creek is predominately sodium-sulfate in dissolved solids. Based on BLM and USGS sampling programs, the structures/systems have an insignificant impact on the chemical quality for area waters.

Over the last 30 years BLM has been concerned with suspended sediment concentrations. A major portion of the sediment loads are derived naturally from geologically eroding soils and parent materials. Efforts, through the Willow Creek Conservation Project, have been made to lessen the rates of upland and channel erosion. This effort and its effects are discussed in the Sediment Yield section. Due to the fine, clayey soil textures in the basin much of the sediment load remains in colloidal suspension even when water velocities approach zero. Long term average turbidity levels in reservoirs are high (less than 1.0 Secchi disk depth). Whether flowing or not, the water is always brownish in color. High turbidity levels in Willow Creek are caused by suspended soils and geologic materials. Suspended sediment measurements of the USGS gauge were discontinued in 1964. Up to that time a maximum daily concentration extreme was recorded at 58,000 mg/l.

WATER USE

The structures/systems related to this plan were inventoried for water use quantification in 1979. In 1981, these uses were claimed as "prior use" sources in the Montana Statewide Adjudication Program. At the time this document was written none of the structures/systems were decreed by the Montana State Water Court. Any additional storage or use of water under the alternative to be selected will be applied for under the Montana State Water Permit System. Likewise, any decreases or eliminations of claimed uses will be coordinated through the Montana State Water Rights Bureau.

RUNOFF CONTROL

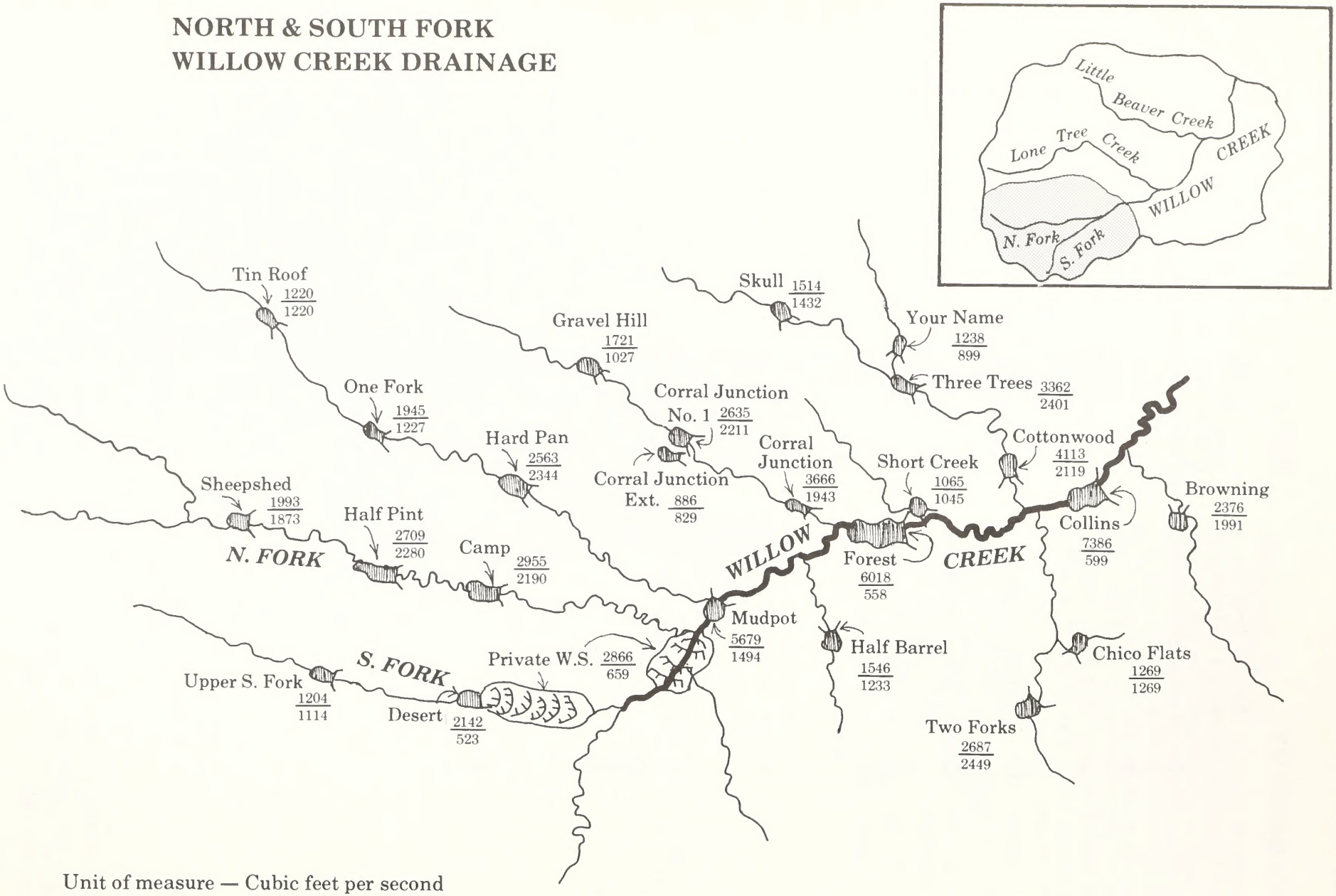
Land use planning objectives, from Chapter 1, state that runoff in Willow Creek must be controlled in part by constructing and maintaining flood control structures and systems. This section describes, for purposes of planning, the effectiveness of structures/systems on flood peak attenuation based on inventory and synthetically generated data.

There are several "state-of-the-art" flood routing computer models available. The analysis used in this planning effort was based on the Corps of Engineers' HEC I flood hydrograph modeling package (U.S. Army, 1981). The reasons for selecting this model and a discussion of the hydrologic input data are provided in Appendix 2.1A. The model operation and related analysis were done for the BLM by the U.S. Geological Survey as part of an interagency study agreement. The intentions of BLM and USGS are to eventually calibrate this model, using onsite runoff and climatic data, then transfer the model program to BLM's computer facilities for future use in survey and design of structures/systems during implementation of this plan.

A 100-year return frequency rainfall intensity was selected for input, which then produced resultant flood flows throughout the drainage. The 100-year storm was used to show the effects that structures/systems have on extreme flood discharges. Using this storm event, basin data and the model, several scenarios (various arrays of structures/systems) were analyzed. An example of two contrasting scenarios would be a flood with all the structures/systems functioning as they were designed, and then the nonexistence of structures/systems within the entire basin. Because of the different scenarios and analyses possible with 83 reservoirs and 9 dike systems, only one flood magnitude (100-year return frequency) was used in the modeling effort.

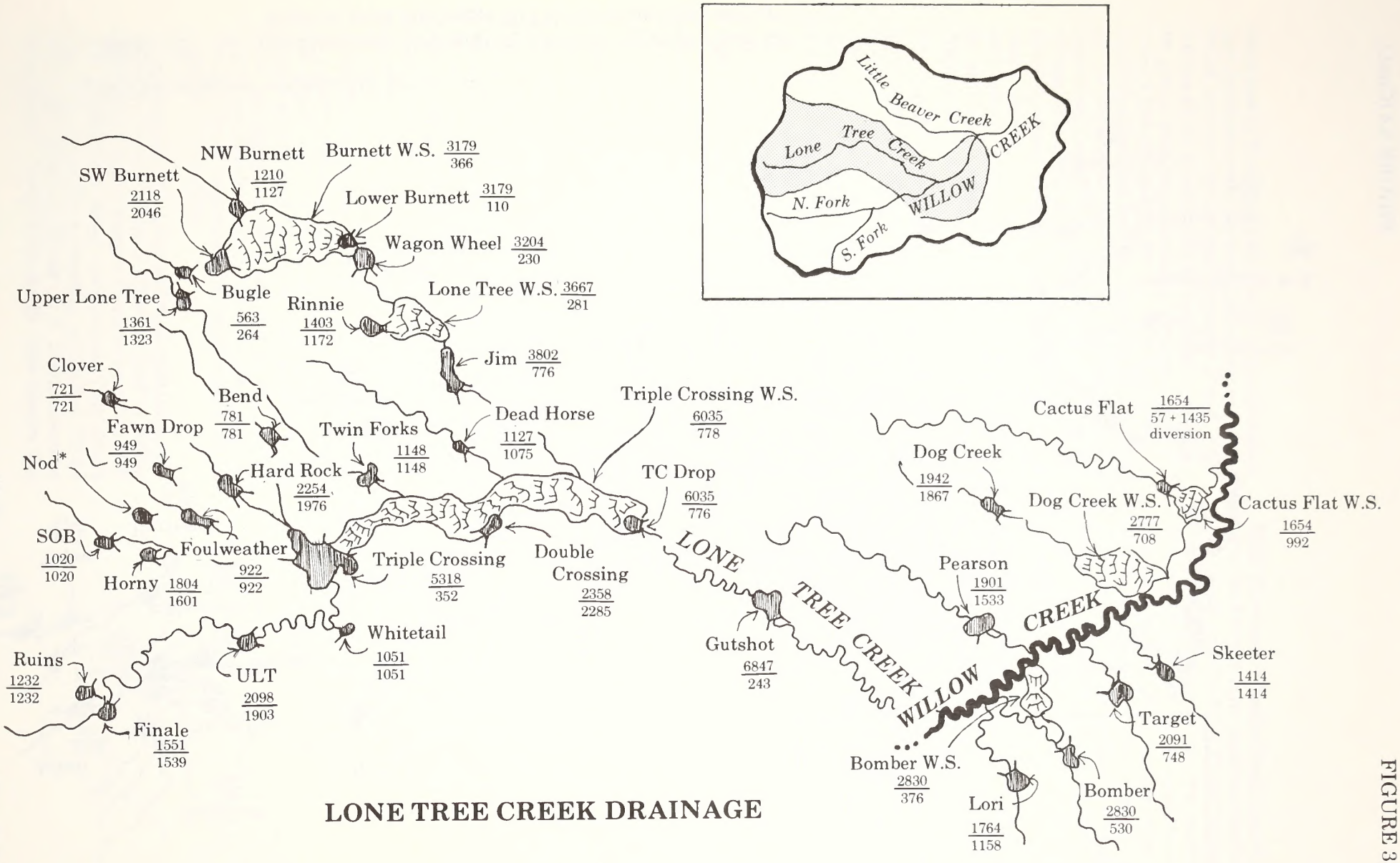
The model provided maximum discharge peaks at points throughout the basin. Points of interest are at the mouth of Willow Creek drainage (USGS stream gauge); the inflow locations of each structure/system and the outflow of each structure/system. Although discharge peaks are primarily the basis of this planning analysis, model output also contained hydrograph plots, volumes, durations, etc. Figure 3.4 shows two values of discharge peaks at the key points. This figure enables a comparison of flood peak values with and without the structures/systems. From the modeling results, there is a 79%

FIGURE 3.4 PEAK DISCHARGE WITH AND WITHOUT FLOOD STORAGE EFFECTS



Unit of measure — Cubic feet per second

KEY $\frac{273}{73}$ — Outflow peak discharge WITHOUT upstream flood storage effect.
Outflow peak discharge WITH upstream flood storage effect



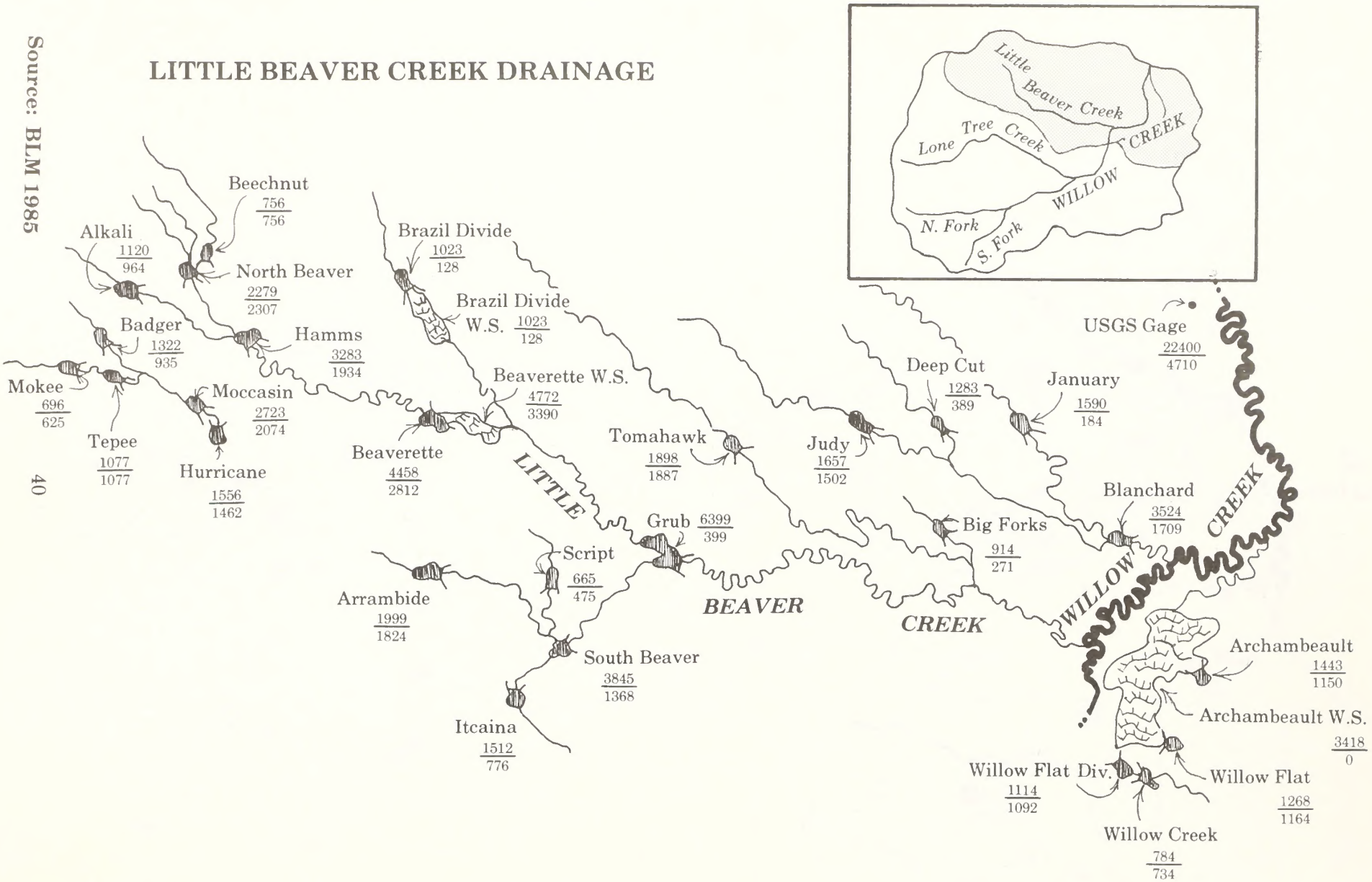
LONE TREE CREEK DRAINAGE

* no analysis available

Unit of measure — Cubic feet per second

KEY $\frac{273}{73}$ — Outflow peak discharge WITHOUT upstream flood storage effect.
Outflow peak discharge WITH upstream flood storage effect.

FIGURE 3.4 (Cont.)



Unit of measure — Cubic feet per second

KEY $\frac{273}{73}$ — Outflow peak discharge WITHOUT upstream flood storage effect.
Outflow peak discharge WITH upstream flood storage effect.

Source: BLM 1985

FIGURE 3.4 (Cont.)

decrease in flood peak discharge at the mouth of the drainage area due to the effectiveness of the flood control structures/systems. Flood peak values of the mouth with all structures/systems in place and no structures/systems in place were 4,710 cfs and 22,400 cfs, respectively. It is important to note that the flood model assumes all 94 structures/systems in the basin to be operating normally or functioning as they were designed to do. In reality, there are many structures/systems in need of maintenance; some of them, due to complete failure, no longer detain any runoff. A discussion on model verification is provided under the hydrology section of Appendix 2.1A.

The USGS estimated that conservation structures/systems reduce peak discharge about 45% (Frickel, 1972). This estimate was based on a July 1962 flood analysis using gauge data at the mouth and indirect channel measurements in uncontrolled areas of the basin. Both the modeling analysis and 1962 estimates show that conservation structures/systems have significant effects on reducing flood peak discharges in and from the Willow Creek Basin. Many of the individual structures/systems significantly reduce onsite flood peak discharges in their local areas of the basin. As impacts are described in Chapter 4 for each alternative, the results of HEC I modeling scenarios are used as the basis for determining changes, if any, in flood peak discharges.

Another important land use objective identified in Chapter 1 is that the structures/systems, along with other watershed conservation practices, afford protection to Willow Creek/Milk River area from severe flooding. The land downstream from the planning boundary to the confluence with the Milk River is predominately in private ownership. Most of this private land is managed for livestock grazing or irrigated-subirrigated crop production. The BLM limited this planning effort only to that portion of Willow Creek and its drainage that is predominately public land. However, due to the above land use objective and a variety of laws, BLM must consider the effects of its actions on downstream areas especially in cases where flood control is a question.

Consequently, this plan will deal with the structures/systems and their effectiveness in reducing flood peak discharges in areas near the Willow Creek/Milk River confluence. This effort has been aided by a recently published Flood Plain Management Study (U.S. Department of Agriculture, 1984). This study area covers the Milk River and Cherry Creek near Glasgow and extends downstream past the confluence of Willow Creek and the Milk River. A graphical illustration of this flood plain area is shown in Figure 3.5. Glasgow lies upstream from the confluence. The Soil Conservation Service of Bozeman, Montana, was contacted to assist BLM and USGS in using the Flood Plain Management Study in assessing the effects flood peaks from Willow Creek have on the confluent area.

This assessment is mainly related to the confluent area and areas upstream from the confluence. Historically, it is these areas that have been impacted during periods of flood discharges from Willow Creek. By referring to the map, both Highway 24 and the bridge control downstream flows, but upstream this constriction will cause backwater effects toward Glasgow.

FIGURE 3.5 MILK RIVER, WILLOW CREEK CONFLUENCE AND FLOOD PLAIN AREA

100 year flood plain cross sections

100 year flood plain

SOURCE: Flood Plain Management Study — U.S. Department of Agriculture

By using the cross sections derived by the flood plain study, the flood peaks produced by the HEC I Model can be extrapolated from the basin planning area to the confluent area. A cross section is a geometric description of a river valley floor (including the channel) with computed discharge capacities at elevation points along the cross sectional line. The cross sectional line must be perpendicular to the line of flow. These assumptions were made to enable this assessment.

1. The BLM planning boundary is at the point where the USGS gauge is located, approximately 10.6 stream miles upstream from the confluent area. The assessment does not consider runoff contributed by tributaries within this 10.6 mile reach.
2. Only the discharge peaks from this point 10.6 miles upstream are used with the river valley cross sections. Milk River discharges are nonexistent. This assumption is made so that only BLM actions in the planning area of the basin and their sole impact on the confluent area may be evaluated.
3. Even though modifications are proposed for the bridge on Montana Highway 24, which crosses the Milk River near the confluent area, discharge capacities at this cross section will not significantly change.
4. Extrapolated discharge peaks remain equal in value for five assessed cross sections upstream from confluent area. This assumption ignores the dynamics of discharges as their values would change while progressing upstream from the first cross section encountered. Perhaps this is an exaggerated situation of how flood flows from Willow Creek would behave (i.e., a "worse-case situation").

A flood peak of 22,400 cfs, a representative peak from Willow Creek without effects of structures, would lie within the 100-year flood plain boundaries. The 100-year flood plain boundaries are delineated in the SCS document. The estimated flood plain acreage impacted by flooding is 2,200 acres. This flood plain acreage is that area which lies between the 100-year flood boundaries and the banks of both the Milk River and Willow Creek. The impacted acreage equals 12% of the total 100-year flood plain study area along the Milk River. Due to a 500-year designed levee system surrounding Glasgow, the town is not impacted by these discharges from Willow Creek. Glasgow is also located upstream near the fifth cross section analyzed. If a flood peak discharge with the structures/systems in place is extrapolated to the confluent area there are little to no impacts from flooding. Most of this discharge is restricted to the banks of both the Milk River and Willow Creek (flood plain management study refers to this area as lying within zero damage elevations). In summary, BLM's original 1952 Conservation Project contributes to flood protection in the Milk River/Willow Creek confluence area. The effects are apparently minor since Willow Creek flood flows, without BLM's conservation structures/systems, impact 88% less area than the 100-year flood from the Milk River in the confluent area.

SEDIMENT YIELD CONTROL

Land use objectives state that BLM will control erosion and sediment yield. The original conservation plan identified control of sediment yield from Willow Creek as a primary purpose of conservation structures/systems. Due to ongoing Missouri River Basin planning, then and now, reducing sediment yields from Willow Creek became an important objective.

Any structure/system which detains or slows flood runoff, reduces channel erosion and sediment yields. Although the water spreading dikes systems detain flows and reduce sediment yield, the detention and retention reservoirs have the greatest capacities for storing sediment. Studies have shown that once a detention dam has filled with sediment, meaning sediment levels are equal to principal spill elevation, the reservoir still has a capacity to store sediment (Lusby, 1967). Essentially, a sediment wedge is formed with elevations of sediment levels being higher than the elevation of the principal spillways. With this fact, a silted full reservoir will retain a portion of its effectiveness to retain sediment.

From earlier discussions, it is obvious that Willow Creek is naturally eroding at high rates. Due to ecological limitations in vegetative cover, upland sediment yields will continue in decreasing amounts. Because of fine textured soils and geologic parent materials and existing basin gradients, channel and gully erosion rates are difficult to alter. The predominately fine textured sediment loads are hard to control by channel barrier methods. The positive benefits of structures/systems in Willow Creek are accomplished in two ways:

1. Coarser sediment particles, which can be most damaging to downstream channels in terms of active erosion agents, are deposited in reservoirs. This continues to be the case after a reservoir has filled with sediment.
2. Stream flow velocities are reduced due to detainment by the structures. Since sediment yield rates are naturally high, the value of retention structures is questionable. In relatively short periods after construction, this type of structure becomes a detention facility.

According to USGS, sediment yields vary greatly in the basin. Measured yields from 1954 through 1964 ranged from 0.09 to 2.00 acre-feet/square mile/yr. (Frickel, 1972). Their studies indicated that the amount of sediment per unit of runoff at the USGS gauge was reduced by 55% during the 1962 through 1964 period. Reductions were attributed to increased sediment retention from new reservoir construction. Current sediment storage is significantly less than it was in 1964 since no new structures have been built. Fifty-four percent of the detention structures in place during 1966 have filled with sediment. Detention structures were designed to hold 25 years of sediment.

Based on a 1984 capacity survey of structures/systems, BLM estimates there is 3,400 acre-feet of storage remaining. This figure may be inflated by considering the wedge effect on reservoirs that have filled with sediment. The remaining capacities control 217 square miles, or 40% of the basin. Beginning in 1963, the USGS estimated that the average life of reservoirs would be 62 years; however, the useful life for storing sediment would be much shorter because the rate of loss of sediment capacity becomes smaller each year (Frickel, 1972). Based on average annual sediment yields of .93 acre-feet/square mile and observed losses of reservoir capacity since 1966, BLM estimates that approximately 18 to 20 years of useful life (retainment of sediment) remains for the existing reservoirs. A mean of about 307,000 tons per year will be stored during the next 18 years. It is necessary to remember that structures/systems maintain sediment yield control efficiencies once they are silted full because they continue to detain erosive flood discharges.

CHANNEL EROSION CONTROL

It is the opinion of many individuals who have studied the Willow Creek watershed that channel erosion is a major contributor to sediment yields. When land use objectives recommend BLM to reduce erosion in Willow Creek, then conservation efforts must focus on channel erosion. Channel barriers such as the Willow Creek structures/systems improve channel conditions by adjusting channel gradients and slowing erosive streamflow velocities.

During the period of 1955 through 1967 the USGS determined that the channel cross-sectional area of its stream gauge had become smaller. The change in channel geometry presumably occurred in response to reduced peak discharges and prolonged periods of low flow brought about by the detention reservoirs constructed in the basin (Frickel, 1972).

Photo files from the Valley Resource Area Office were used to obtain photographs showing head-cutting or channel erosion in the Willow Creek drainage. Photos with identifiable locations were selected for comparison. The dates of the photos ranged from 1944 to 1967; most were taken in the 1950's. The locations within the basin varied, with emphasis placed on the Collins Ranch and headcut. Photos of the original locations were retaken in September 1984 with the aid of a helicopter to realign a comparable frame. Refer to Figure 3.6 for a sample of photo pairs from a more complete file available in the resource area office. Arrest of headcuts, channel stabilization, and extent of downstream effect due to particular structures/systems are illustrated by comparing the two photos.

Caution should be used in viewing photos as these are localized pictures, and do not represent all areas in the basin. Also, other management changes, besides structure/system placement were going on at the same time. For example, the disappearance of severe headcuts may be because of their existence at points which are currently in reservoir sediment storage areas. In summary, although structures/systems have improved channel conditions, overall channel stabilization is highly dependent on their distribution and density throughout the basin.

FIGURE 3.6 — TREND PHOTOS OF CHANNELS & GULLIES

1. Aerials of Willow Creek showing Collins headcut. Note revegetation in reservoir. Location: T25N, R37E

(a) 8/52

(b) 9/84

2. Aerial close ups of Collins headcut. Note consecutive shifts of the trail, suggesting the high rate of headcutting.

Location: T25N, R37E

(a) 7/52

(b) 7/62

(c) 9/84

3. Ground photos of Collins headcut shows healing due to effect of Collins detention dam. Structure was completed December, 1957.
Location: T25N, R37E, S24

(a) 4/49

(b) 9/84

4. Aerials of Archambeault Spreaders with Willow Creek road running across the photo. Note headcutting below the bottom dike.
Location: T26N, R39E

(a) 10/53

(b) 9/84

5. Aerials of Lone Tree Creek above Gutshot detention dam, looking downstream. Old photo (a) is approximately ½ mile downstream of the new photo. Note channel bottom. Location: T26N, R37E, S33

(a) 8/52

(b) 9/84

(a) 7/52

6. Aerials of Burnett Headcut detention dam. Note headcutting.
Location: T27N, R35E, S29

(b) 9/84

7. Ground photos of outlet from Sheepshed detention dam. Note channel healing. Location: T25N, R35E, S26

(a) 5/55

(b) 9/84

(a) no date

8. Ground photos of Hay Coulee, looking downstream, approximately one mile below Bomber detention dam. Note channel healing.
Location: T25N, R38E, S15

(b) 9/84

VEGETATION

The most common plant species in the area includes western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), Sandberg bluegrass (*Poa sandbergii*), prairie sandreed (*Calamovilfa longifolia*), green needlegrass (*Stipa viridula*), big sagebrush (*Artemisia tridentata*), nuttall saltbush (*Atriplex nuttallii*), willos (*Salix spp.*), boxelder (*Acer negundo*), and cottonwood (*Populus spp.*) trees along some drainages and reservoirs (See Missouri Breaks EIS for a more complete description).

No rare or endangered plant species are known to exist on public lands in the Willow Creek Basin.

The objective to provide herbage for livestock, watershed, and wildlife was identified in both the Missouri Breaks and the Prairie Potholes EISs. These documents also established the livestock grazing preference for each allotment. Livestock forage allocations are not addressed in this environmental assessment (EA).

The nine water spreader systems currently produce approximately 2,328,000 pounds of herbage for livestock, wildlife and watershed. Livestock are allocated 388,000 pounds of herbage or 485 animal unit months (AUMs). The remaining 1,940,000 pounds of herbage is allocated to watershed and wildlife and plant maintenance.

Approximately 42,326,400 pounds of herbage is produced in the Willow Creek Basin; outside the water spreader systems. Half of this herbage is allocated to livestock, the remaining to wildlife, watershed and plant maintenance.

The Willow Creek Basin was divided into three broad soil groups to determine the general ground cover in the basin. Figure 3.2 explained the soil units and corresponding curve numbers used to develop soil groups. The percent of ground covered by the groups is:

Soil Group	To Ground Cover
1	50 to 60%
2	20 to 30%
3	70 to 80%

Figure 3.2 shows extensiveness of soil units which make up the soil groups identified above. The structures/systems, except for the water spreader systems, have an insignificant impact on ground cover. The herbage production figures on the spreader systems correlate well with increasing or declining ground cover.

Livestock also use the forage allocated to watershed and wildlife. The result is a change in distribution pattern that results in lighter livestock use on adjoining uplands. Table 3.2 illustrates the pounds of herbage produced on the nine water spreading dike systems.

TABLE 3.2: HERBAGE PRODUCED ON WATER SPREADING DIKE SYSTEMS

	Acres	Existing Pounds of Herbage	Pounds of Acreage Per Acre
1. Burnett W.S.	1,028	492,800	479
2. Brazil Divide W.S.	994	44,800	45
3. Beaverette W.S.	129	62,400	484
4. Lone Tree W.S.	118	56,000	475
5. Archambeault W.S.	1,458	699,200	480
6. Bomber W.S.	211	100,800	478
7. Cactus Flat W.S.	84	40,000	476
8. Triple Crossing W.S.	1,327	636,800	480
9. Dog Creek W.S.	406	195,200	481
TOTAL		2,328,000	

Source: BLM 1985

GRAZING MANAGEMENT

There are presently 17 operators and 2 grazing associations with grazing permits in the project area. There are a total of 26,939 licensed Federal animal unit months (AUMs) in the grazing allotments within the Willow Creek Basin. The boundaries of these grazing allotments don't necessarily coincide with the boundaries of the Willow Creek Basin. Nine allotments have allotment management plans (AMPs) and five AMPs are proposed for other allotments in project area (see Table 3.3).

The objective to provide livestock water is identified in both the Prairie Potholes EIS and the Missouri Breaks EIS as necessary to implement the allotment management plans. Properly placed livestock waters, along with approved grazing management practices, increase weight gains, improve range condition and reduce stress on the livestock.

Twelve of the existing reservoirs provide necessary season long water for livestock and 14 reservoirs provide water until approximately July 15. Fifty-two reservoirs supply only small amounts of stockwater in the early spring because they have filled with sediment. Five reservoirs were rated as low value because of other nearby water supplies. The complete description of these values and how they were derived, is given in Appendix 2.1D. Ten detention reservoirs support water spreader systems.

TABLE 3.3: EXISTING AND PROPOSED AMPS

			EIs		Range Condition				Federal AUMs			
Allotment	Allot. No.	MGT. Cat.	Proposed System	Current System	Excel %Acres	Good %Acres	Fair %Acres	Poor %Acres	Season of Use	Allot.	Project & Area	Apparent Trend
* Mud Creek	4577	I	P(RR)	E(S)		43(1858)	57(2463)	0	6/20-11/15	360	360	
* Craig Creek	4580	I	P(RR)	P(S)	0	80(77096)	20(19274)	0	5/1-11/30	8,598	5,744	
Lewis/Bomber	4585	M	R(RR)	E(RR)		71(18122)	24(5067)	5(985)	4/1-9/30	2,500	2,300	
* S.F. Willow Cr.	4589	M	P(RR)	E(DR)	3(311)	93(9340)	4(400)		5/1-10/30	1,138	1,138	
* Willow Creek	4590	M	R(RR)	Pt(S)	1(600)	76(49645)	20(12986)	3(2269)	4/1-9/30	4,534	4,534	
Upper Mud Cr.	4586	M	P(DR)	E(RR)	0	71(1558)	29(638)	0	5/1-10/15	232	232	
Lone Tree	4581	I	P(RR)	E(RR)	2(640)	48(21200)	44(19450)	6(2760)	5/1-10/30	2,772	2,772	
Lower Little Beaver	4583	I	E(RR)	P(S)		52(12846)	42(10001)	6(1320)	5/1-10/30	2,322	2,322	
[1] Upper Brazil 4551	4551	I	P	P(S)		21(6107)	79(21941)		5/1-10/30	3,018	1,848	
[1] Upper Beaver 4552	4552	M	P	E(RR)	0	65(7370)	35(3949)		5/1-10/30	1,032	944	
[1] Miller Coulee 4574	4574	I	E	E(RR)	0	8(1929)	91(20656)	1(145)	4/1-10/30	2,300	2,300	
[1] Coyote Creek 4563	4563	I	E	E(RR)	0	59(5118)	40(3274)	1(127)	5/1-10/15	957	431	
[1] Lower Willow Creek	4576	M	E	P(S)	0	32(1894)	68(3943)	0	6/1-10/05	488	488	
[1] Little Beaver Creek	4573	I	P	P(S)		35(2749)	65(5470)	0	4/10-10/26	705	705	
[1] Brazil Creek	4553	I	P	P(S)	0	29(7906)	68(18158)	0	5/1-10/30	3,503	821	
TOTAL					1(1551)	59(224738)	39(147670)	1(7606)		34,459	26,939	

* Reconditioned since 1980
[1] Conditioned during SVIM effort
E Implemented AMPs
P Proposed AMPs
RR Rest Rotation
Pt Potential AMP
DR Deferred rotation
S Seasonal

Source: BLM 1985

WILDLIFE

Wildlife in the Willow Creek watershed is typical of the Eastern Sedimentary Plains. The abundance and distribution of species and individuals is similar to adjacent areas of the same landform, but distinct from the Missouri Breaks to the south and east. There are 4 big game, 4 upland bird, 11 waterfowl and 3 endangered species of major concern to this plan (see Table 3.4). A complete list of all wildlife species for this zone is on file at the Valley Resource Area Office.

The classification of Willow Creek's wildlife habitat is divided into regional and local designations, based on professional opinion. These designations are founded on an understanding of the habitat requirements of each species.

The regional designations are called "qualities" and include good, fair and poor. They allow gross comparisons to other areas in Montana or in other states. There is only one habitat quality per species.

The local designations are called "values" and include crucial, high, medium and low. They allow habitat comparisons within a smaller area and there can be two or more habitat values per species. Local values are a subdivision of regional habitat qualities.

Shallow, infertile, erosive soils with high sodic-acid contents and low precipitation combine to limit wildlife habitat potential in the Willow Creek Basin. On a regional basis the waterfowl, sharp-tailed grouse, gray partridge and pheasant habitat quality is considered poor, while sage grouse habitat is fair to good. The antelope range is probably fair quality with mule deer habitat being fair to poor. The area is essentially nonhabitat for white-tailed deer. Local values are detailed in the individual species accounts given later in this section.

TABLE 3.4: WILDLIFE OCCURRENCE

Big Game

Mule Deer - Odocoileus hemionus
Whitetailed Deer - Odocoileus virginianus
Pronghorn Antelope - Antilocapra americana
Elk - Cervus elaphus

Endangered

Bald Eagle - Hallaeetus leucocephalus (Recorded sighting)
Peregrine Falcon - Falco peregrinus (No recorded sighting)
Black-footed Ferret - Mustela nigripes (Possible habitat south of Willow Creek)

Upland Gamebird

Sage Grouse - Centrocercus urophasianus
Sharptailed Grouse - Typmpanushus phasianeuclus
Ring-necked Pheasant - Phasianus colchicus
Gray Partridge - Perdix perdix

Waterfowl

Canada Geese - Branta canadensis
Mallard - Anas platyrhynchos
Pintail - Anas acuta
American Widgeon - Anas americana
Gadwall - Anas strepera
Northern Shovelier - Anas clypeata
Green-winged Teal - Anas crecca
Blue-winged Teal - Anas discors
Lesser Scaup - Aythya affinis
Redhead - Aythya americana
Canvasback - Aythya valisineria

Source: BLM 1985

The existing watershed structures do influence the project area's wildlife. Five reservoirs provide high value general wildlife habitat, 20 are rated as medium value and 58 were classed as low. Within the low value group 38 are recommended for abandonment and, of those, 33 essentially hold no water for any time period. The water spreaders currently provide no high value habitat, but five of the systems are classified as medium value and seven more are low value with two of those recommended by wildlife for abandonment. A summary of the structures/system values is shown in Table 2.3, Alternative Summary. Appendix 2.1B (Wildlife Ratings) portrays habitat provided by individual watershed facilities.

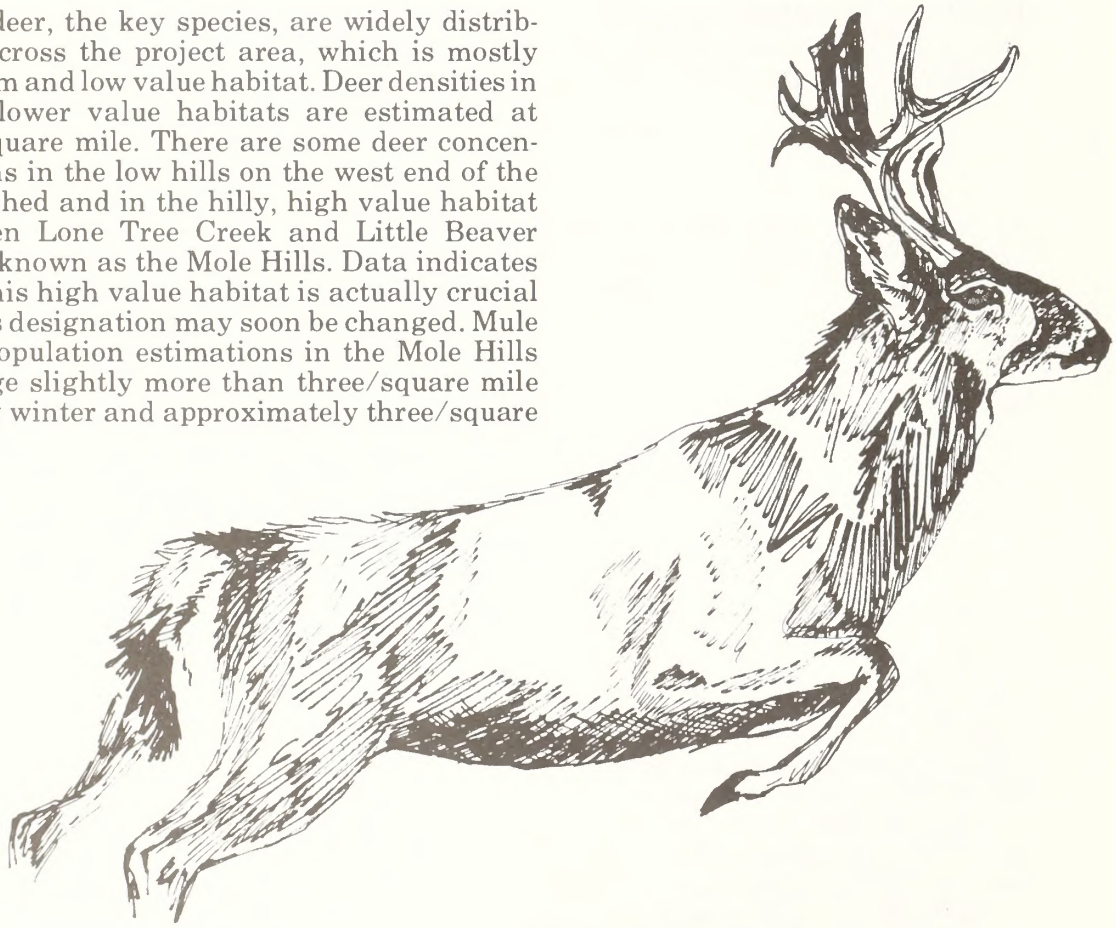
Density and population estimates in this section should be considered relative indications, gathered from Montana Department of Fish, Wildlife and Parks files and Bureau sighting files, rather than accurate census figures. The numbers are provided to give an appreciation of the watershed's wildlife value in comparison to other areas the reader may be familiar with.

BIG GAME

Mule deer, the key species, are widely distributed across the project area, which is mostly medium and low value habitat. Deer densities in these lower value habitats are estimated at one/square mile. There are some deer concentrations in the low hills on the west end of the watershed and in the hilly, high value habitat between Lone Tree Creek and Little Beaver Creek known as the Mole Hills. Data indicates that this high value habitat is actually crucial and its designation may soon be changed. Mule deer population estimations in the Mole Hills average slightly more than three/square mile during winter and approximately three/square mile in summer. The high value habitat in the Triple Crossing Water Spreaders (TC Dikes) probably have similar or higher densities.

Mule deer populations are affected by watershed structures. Large dams which still hold water provide a drinking source to a broad area. This is helpful, but water availability is not a limiting factor on mule deer in this area. These structures provide the vegetative components of mule deer habitat especially in spring and summer, less so in the fall and not at all in the winter. Some structures which support willow (*Salix spp.*) and cottonwood (*Populus deltoides*) stands have a cover value for mule deer. Reservoirs and water spreaders which provide lush vegetation, relative to the surrounding habitat, are a herbaceous forage bonus for mule deer, but non-shrub forage quantity is not presently a determining factor determinant for mule deer numbers.

A few facilities, such as the TC Dikes, provide both quality forage and cover but the main benefit these projects give mule deer is probably forage quality.



A number of the dams and dikes, with their disturbed areas and high water regimes, are heavy forb producers. Forbs are valuable mule deer diet items during the spring, especially for pregnant and lactating does. The impoundments are also the only zones of green vegetation, both grasses and forbs, available during the frequent droughts of this region; deer can be seen concentrated in these basins during dry years.

The watershed structures benefit mule deer but do not provide factors that are immediately limiting. Any increase or decrease in dams or dikes would not be reflected in rapid mule deer population changes, but may have a minor influence on long-term population trend and fluctuations.

Pronghorn antelope, another key species, use the entire area, which is primarily medium value habitat with some pockets of low and high value. The high value inclusions are winter range that, like the high value mule deer habitat, occur on the Bear Paw shale hills of the west and east ends of the area. Average antelope density could be characterized as slightly greater than one/square mile.

Antelope benefit from watershed projects in some of the same ways as mule deer in the spring, summer and fall, but gain essentially nothing in the winter. The forage and water provided by some facilities is used by antelope; the main watershed contribution being the improvement of forage quality and variety through the provision of relatively dense forb growth. Antelope do not benefit from cover provided by structure-induced riparian vegetation because; being open ground animals, they shun dense vegetation. The Valley Management Framework Plan (MFP) and the Prairie Potholes EIS direct that important antelope habitat be maintained or improved.

White-tailed deer are occasionally seen in the watershed but are so few in number (less than one/square mile), as to be insignificant. The basin area is currently rated as nonhabitat, with narrow stringers of low and medium habitat along major drainages and on certain watershed facilities.

The watershed structures impact whitetail principally by providing more potential for riparian vegetation. Whitetail have been observed in riparian zones associated with both watershed dams and spreaders. While not currently an important species in the area, whitetail could become significant in the long term, if substantial riparian development occurs on watershed structures and associated drainages.

Elk are incidental users of the Willow Creek watershed with densities far below one/square mile. This is designated nonhabitat and is closed to elk hunting but elk are apparently forced into it by hunting pressure in neighboring areas. While elk use generally occurs annually, the animals do not stay in the area year around, preferring instead to move back into the Missouri River Breaks. The elk presently use the open prairie habitat type and apparently are not significantly affected by the watershed structures.

Elk are attracted to riparian zones and, should such vegetation continue to develop in connection with some watershed structures over the long term, use of the watershed might increase to a minor degree. This would provide an interesting, if insignificant, extension of elk habitat.

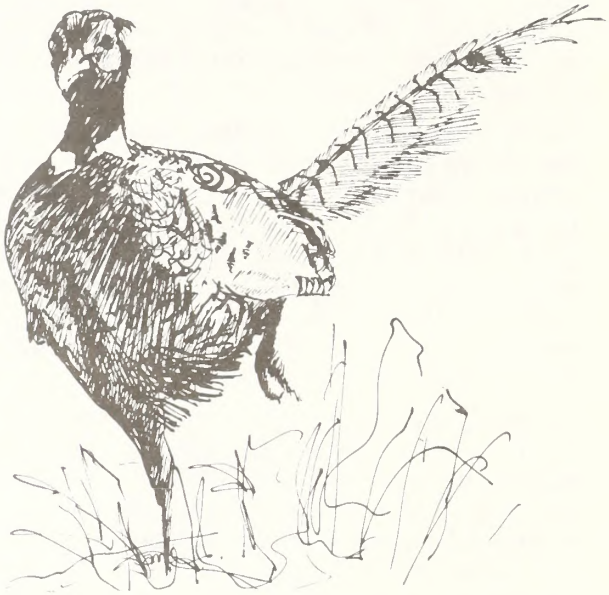
UPLAND GAME BIRDS

The entire basin area is sage grouse habitat with values ranging from crucial to low. These birds are a key species for this area with 22 reported leks within the watershed, 18 of which are active. Based on averages of spring survey data for these 18 leks a minimum of 5,700 birds probably exist at the start of the hunting season. Due to the uniformity of the habitat, the population minimum can be expressed as approximately 11 grouse/square mile. This is a minimum population figure since there are many additional leks that have not yet been discovered and counts were not necessarily made during peak attendance at the strutting grounds.

Detention dams and water spreaders have several positive aspects for sage grouse. These structures provide water and cover that, while not particularily critical for these grouse populations, is undoubtedly quite helpful to them. The principal use these tetraonids make of the developments is forb consumption. Hens with broods concentrate around projects which are heavy forb producers. The diet of young sage grouse is mainly forbs along with some insects which also can be found in abundance near impoundments. The maintenance and protection of valuable sage grouse habitat is an objective of the Valley MFP and the Prairie Potholes EIS.

Much of the basin area is nonhabitat for sharptailed grouse but approximately 1/3, or about 100,000 acres, is crucial through low value habitat. The highest sharptail values and most of the habitat occurs on the south and east perimeters of the watershed. These areas are on the edge of the Missouri Breaks, which contain some of the best sharptail habitat in the region since a very high number of leks have been recorded there. Data from 19 of the 23 reported leks on or near the watershed suggest a minimum estimated population prior to hunting season of about 500 birds; an approximate density of slightly over three grouse/square mile. The estimate is low due to the certainty that many other leks remain undiscovered and that the majority of present census data was not taken during peak attendance, thereby underestimating the populations of individual dancing grounds. This perimeter area is not typical of the majority of the watershed.

Watershed structures don't significantly compensate for the lack of sharptail potential within the core of the unit. The upland sites are not suitable for the bird and, while not particularly known as a riparian species, the small amount of low value sharptail habitat in the area's interior exists solely along drainageways. These stream courses and impoundments sustain woody communities, i.e. willow, box elder (*Acer negundo*), rose (*Rosa spp.*) and snowberry (*Symphoricarpos alba*). The unit's worst deficiency is its inability to produce substantial buffaloberry (*Shepherdia argentea*) stands, an absolute prerequisite for good sharptail habitat in this area. The maintenance or improvement of sharptailed habitat is an objective in the Prairie Potholes EIS.



Pheasants have a limited distribution along certain riparian zones within the watershed. High, medium and low value habitats exist within the plan unit but the majority of the area is unoccupied and numbers are probably very low; no survey data exists. Only the riparian zones with the heaviest growth have any potential for pheasants; the highest value habitat is that closest to farmland.

As with several other species, water spreaders and dams can only provide riparian habitat for the pheasants, thus allowing some expansion of their range. The overall impact on the pheasant population is and will be minor.

Gray partridge are an extremely low density species in the basin area; no survey data exists. Like pheasants, their only suitable habitat in the Willow Creek Basin is along stream courses, but they are encountered even more rarely than pheasants. Partridge are not abundant anywhere in Valley County and the potential for them to increase beyond their present numbers probably does not exist in this watershed.

WATERFOWL

All the waterfowl species endemic to the Eastern Sedimentary Plains occur in the Willow Creek Watershed (see Table 3.4) and they are the wildlife group most readily affected by the alternatives of this plan. The presence or absence of a water body can increase or decrease, respectively, site-specific waterfowl populations by 100%. No other wildlife species or group is so directly and quickly impacted.

There is some naturally occurring waterfowl habitat along creeks and low-lying areas in the Willow Creek Basin, but it is limited in quality and quantity. The majority of the waterfowl habitat is on reservoirs and water spreaders. Range reservoirs contribute some habitat but are not as significant in this area as watershed facilities. Dams and dikes exhibit a wide variety of habitat quality ranging from high value to nonhabitat.

The provision of waterfowl habitat is identified in the Valley MFP. Of the 83 existing watershed reservoirs, 43 provide some type of waterfowl habitat on approximately 2,000 surface acres. The other 48% of the watershed reservoirs provide no habitat due to a lack of storage capacity, either through design or siltation. These 2,000 surface acres provide habitat for an estimated annual average of about 700 duck breeding pairs, 130 duck broods and 100 Canada geese. This represents nearly 53% of the duck pairs, 59% of the duck broods and 80% of the geese in the watershed and it is accomplished on roughly one-half of the water surface-acreage provided by watershed projects.

These figures can be contrasted with the average annual yields from the water spreading system: having the remaining 50% of the watershed facilities-induced habitat, the spreader dikes provide suitable habitat for approximately 600 duck breeding pairs, 91 duck broods and 30 geese. It appears that while reservoirs and spreaders are equally good duck habitat, the reservoirs are significantly out-producing the spreaders in terms of goose habitat. The estimated number of birds using watershed facilities on a yearly basis are 1,300 duck breeding pairs, 220 duck broods and 130 Canada geese. These populations estimates are accumulated from the Montana Department of Fish, Wildlife & Parks data and BLM sighting files. The duck estimates are minimum figures since they include no estimates of nonbreeders, a class which is generally not recorded on survey and can fluctuate widely from year to year depending on nesting habitat conditions. Approximately 87% of the ducks are dabbling species and 13% are divers.

There have been waterfowl habitat improvement projects installed on watershed structures within the basin area. These developments were intended to increase waterfowl production, especially that of Canada geese. The improvements consist of earth nesting islands built by heavy equipment, and hand-built projects such as rock nesting cribs or piles with sod cores, floating platforms and stationary nesting platforms with nesting substrates of straw bales or soil. All of these structures are placed within an impoundment and are designed to provide a secure nesting and loafing site above the high water line. Presently there are nine watershed reservoirs and one dike system supporting a total of 104 islands, 3 rock cribs, 9 stationary and 3 floating platforms. These habitat improvements occur both singly and in combination on various reservoirs.

RIPARIAN HABITAT

The improvement of riparian zones is one of the Prairie Potholes EIS objectives and is a goal that would impact most of the important species in this basin. In the preceding species discussions the contribution of riparian vegetation has been discussed, as has the ability of watershed structures to produce areas where this potential exists. The extension of riparian habitat is a key method of increasing habitat for most animals other than waterfowl.

FISHERIES

Due to poor water quality and heavy siltation only one fishery now exists in the watershed: the Triple Crossing Water Spreader System. This system has supported northern pike since the early 1960's, but the fishery is very marginal now because of reduced depth. Without an increase in water level and capacity this fishery will be completely lost in the future.

The poor water quality and high silt loads reduce the potential of developing any of the other watershed structures, with the possible exception of Half Pint Reservoir. This structure appears to have the necessary size and depth for a fishery, but additional water quality measurements are needed. This structure is not close to other fisheries or to town and stocking remote reservoirs has not proven feasible, since fisherman use tends to decrease with increased distance from town.

Several species of nongame fish exist in the watershed. The principal fish in watershed structures is the carp. Populations can be substantial; to the extent that during low water years large numbers die and litter shorelines.

THREATENED/ENDANGERED SPECIES

There are three endangered species that either do or could occur in this basin: the bald eagle, the peregrine falcon and the black-footed ferret. There is no known critical habitat within the watershed for any of these animals.

The bald eagle is a spring and winter migrant through the area. One or two individuals are seen on a yearly basis and numerous sightings are on record. During years of high waterfowl populations or heavy carp die-offs, eagles in the area will forage around several of the larger watershed strucures. However, a high concentration of eagles has ever been observed in this area under those circumstances.

Peregrine falcons have never been reported in the watershed. However, the birds could be attracted to waterfowl concentrations on the various watershed facilities. Peregrines have apparently not taken advantage of these watershed concentrations to date.

There have been no documented black-footed ferret sightings in the Willow Creek Basin as the area lacks suitable ferret habitat. However, suitable habitat does exist south of this basin in the Missouri Breaks and west of the basin area in Phillips County. It's extremely remote, but feasible, that a ferret could explore the basin in an attempt to find suitable habitat.

RECREATION AND ACCESS

Land use objectives require maintenance and improvement of public access into the basin area. The current recreational use consists primarily of big game and upland game bird hunting, some off-road vehicle (ORV) use associated with hunting and some fishing at the Triple Crossing spreaders. The Montana Department of Fish, Wildlife and Parks estimates that big game hunting (mule and white-tail deer and antelope) creates approximately 1,300 recreation visitor days (RVD) annually and upland game hunting (sage grouse, pheasant, sharptail) creates approximately 200 RVD. Although the area is along the central flyway, waterfowl hunting is minimal (160 RVD). Northern pike fishing opportunities have existed in the TC spreaders but current existence and/or quality is unknown. It is estimated that 280 RVD of big game, upland game and waterfowl hunting are associated with the existing structures/systems.

There are three main access roads into the Willow Creek Basin from Glasgow. They are: Highway 24 south from Glasgow, a distance of approximately 9 miles; the Beaver Branch Road, a distance of approximately 20 miles; and the Larb Creek Road via Highway 2, a distance of approximately 76 miles.

The deeply eroded drainages limit most vehicle use to ridge lines or roads. Many of the maintained roads cross detention dams providing access to ridges that otherwise are not accessible. There are approximately 76 miles of highly used roads and 300 miles of lightly used roads within the basin.

AESTHETICS

Land use objectives require the BLM to consider recreation values to insure the protection, enhancement and perpetuation of hunting, fishing and other wildlife oriented recreational activities. The structures/systems provide habitat and consequently enhance recreational opportunities in the basin. The physical characteristics are low, rough or rolling hills with numerous visible drainages. Adjacent hills are sparsely covered with grass and low shrubs. Water is usually present in a few drainages and impoundments. Some drainages contain minimal riparian areas with scattered cottonwoods. The main color and form contrast is derived from drainage patterns and occasional trees and shrubs. The landscape over most of the project area is monotonous.

ECONOMIC CONDITIONS

COUNTY EMPLOYMENT AND EARNINGS

Figures for 1977 and 1982 show agriculture, retail trade, services and government to be the main sources of employment in Valley County (see Table 3.5). Total employment decreased by 11% during this period with agricultural employment remaining relatively stable while construction, manufacturing, services and government employment decreased substantially. From 1977 to 1982 total employment in Montana increased by 6%.

TABLE 3.5: VALLEY COUNTY EMPLOYMENT AND EARNINGS BY SOURCE FOR 1977 AND 1982

Item	Employment			Personal Income[1] ($1,000)	
	1977	1982	% Change	1977	1982
Proprietors:					
Farm	785	784	- 0.1	-1,308	-2,638
Non-Farm	511	573	12.1	8,822	7,436
Wage and Salary:					
Farm	236	267	13.1	627	1,623
Ag. Serv., For., Fish., and Other	30	(D)	—	210	(D)
Mining	(L)	(D)	—	170	(D)
Construction	205	156	-23.9	6,326	6,784
Manufacturing	121	97	-19.8	1,132	1,576
Transportation and Public Utilities	325	292	-10.2	5,632	8,515
Wholesale Trade	215	215	—	2,490	3,247
Retail Trade	736	646	-12.2	6,254	6,982
Finance, Insurance and Real Estate	110	159	44.5	1,597	2,459
Services	871	649	-25.5	10,640	9,084
Government	1,001	754	-24.7	10,220	11,672
Total	5,149	4,593	-10.8	45,298	52,400

[1] Wage and salary personal income includes proprietor's income.

(D) Not shown to avoid disclosure of confidential information. Data are included in totals.

(L) Less than 10 jobs.

Source: Bureau of Economic Analysis, U.S. Department of Commerce, Regional Economic Information System, 1984.

Table 3.5 shows county earnings by source for 1977 and 1982. In 1977, services were the major source of earnings with government contributing the next largest portion. In 1982, government was the major source of earnings with services and transportation and public utilities contributing the next largest portions. Agricultural earnings varied during the time period from a low of $627,000 in 1977 to a high of $8,369,000 in 1981 while services and government earnings were relatively stable. During this same time period, total earnings in Montana increased by 10% (adjusted for inflation).

Agriculture is the basic industry of the county with receipts from livestock and crops in 1981 of $43,447,000 and employing an estimated 1,050 workers or 23% of the work force in the county. It is estimated that receipts from livestock and crops generate nearly $42,000,000 in other business activity in the regional economy. This business activity employs an estimated 1,400 workers with earnings in excess of $30,000,000 annually (based on coefficients from the BLM Montana Economic/Demographic Model).

RANCH RELATED ECONOMIC CONDITIONS

In 1978, there were 738 ranches and farms in Valley County (1978 Census of Agriculture, USDC, Bureau of Census). Currently, 17 operators (less than 3% of the county total) and 2 grazing associations have permits for 26,939 BLM animal unit months in the Willow Creek Basin. It is estimated that BLM AUMs contribute $506,000 annually to livestock sales (based on total ranch revenue from livestock sales divided by the number of AUMs required to produce those sales, $18.78/AUM, BLM Ranch Budget Linear Programming Model, 1984). Although this is less than 2% of the livestock and crop receipts for Valley County, these sales provide employment for an estimated 33 workers in agriculture and other business activities in the region (based on coefficients from the BLM Montana Economic/Demographic Model).

WATERSHED RELATED ECONOMIC CONDITIONS

Economic benefits from watershed projects include increased production of forage, sediment reduction, flood control, and increased water availability. Economic benefits can also be produced by such qualitative changes as improved range condition and water distribution. Increased forage production from projects is allocated to watershed and wildlife which subsequently benefits the hunting activity in the area (see Recreation/Wildlife Related Economic Conditions).

Sediment reduction is estimated at 307,000 tons annually for the next 18 years with an economic value of $2,300 per year (based on USDA—NFS benefit values). Increased water availability is not a primary function of these projects; however, livestock and wildlife do benefit from water held throughout the summer in 12 reservoirs and held until mid-July in 14 other reservoirs. These reservoirs provide nesting habitat for waterfowl and subsequently economic benefits from migratory bird hunting (see Recreation/Wildlife Related Economic Conditions).

The economic value from reducing flood hazards accrue through the reduction in actual or potential damages associated with land use. The Willow Creek watershed projects reduce flood hazard on 2,200 acres of agricultural lands from a 100-year storm. The reduction in damage is estimated at $177,000 for a 100-year storm (estimated at $81/acre, based on 1981 crop receipts of $28,831,000 on 406,600 acres harvested in Valley County, adjusted to 1984 dollars).

Since a 100-year storm has a 1% chance of occurring in any given year, the annual economic value is $1,770 ($177,000 x .01). However, this annual value does not account for flood benefits from a 50-year, 60-year or other storm frequencies. To determine the total annual economic value from flood hazard control requires summing the benefits for all storm frequencies based on the probability of occurrence. The equivalent annual economic value of flood hazard reduction is estimated at $6,500 (see Appendix 3.2).

RECREATION/WILDLIFE RELATED ECONOMIC CONDITIONS

Big game and upland game hunting are the primary recreational activities in the study area along with some waterfowl hunting. The economic implications of hunting fall into two categories. The first is the value of the hunting experience (i.e., the value the recreationist would be willing to pay). The other category is the amount of dollars expended for hunting (i.e., direct expenditures for travel, food and lodging). Big game and upland game hunting within the Willow Creek Basin is estimated at 1,500 recreation visitor days annually, while waterfowl hunting associated with duck and geese production is estimated to be 160 RVDs (see Appendix 3.2). It is estimated that existing watershed structures contribute 10% to big game hunting, 20% to upland game hunting and 70% to waterfowl hunting resulting in 280 RVDs associated with existing structures. The economic value from these hunter days is estimated at $7,900 annually (based on USDA—NFS benefit values) while annual hunter expenditures for travel-related expenses amount to $15,000 (1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation). These expenditures are insignificant to business activity in the regional economy.

SOCIAL CONDITIONS

Valley County's population was 10,250 in 1980, a decrease of 10.6% from 1970. The decrease was primarily due to out-migration caused by unemployment. The out-migration rate is less than the decade 1960 to 1970 when the county population decreased by 33% due to the closure of the Glasgow Air Force Base. Glasgow with a 1980 population of 4,455 is the only town with a population above 2,500 in Valley County.

See the Draft Bitter Creek Wilderness Environmental Impact Statement (1984) for a discussion of local attitudes and indicators of social well-being.

WILDERNESS

The Willow Creek Basin contains no wilderness areas or wilderness study areas, (refer to the Montana Wilderness Inventory, November, 1980).

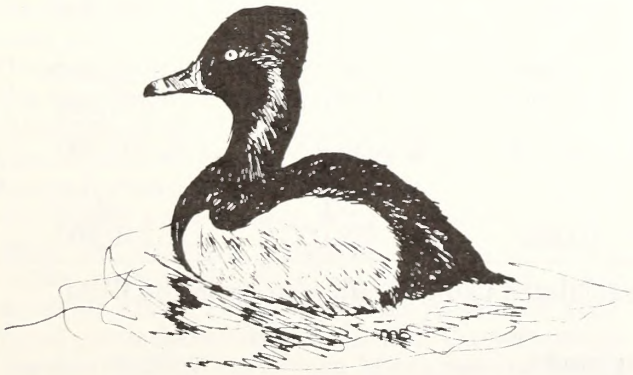
4

ENVIRONMENTAL IMPACTS

This chapter explains the environmental consequences of the alternatives described in Chapter 2. Environmental aspects are analyzed in order to determine the impacts of each alternative. Climate, air quality, topography, geology and wilderness are not analyzed, since none of these components would be significantly impacted by any of the alternatives.

Enough information on both paleontology and cultural resources is available from the Willow Creek Basin to conclude that information gathering, beyond site specific surveys, is not necessary for the alternatives being studied here. For paleontology, each area proposed for ground disturbance should be reviewed to determine if an on-the-ground survey is necessary.

Cultural resource survey in the area is governed by the "Hi-Line Survey Strategy". Where that work is required, it should be done at the Class III level. If cultural resources are found, they would be dealt with on a site by site basis. There is nothing to suggest that mitigation by data recovery would not be possible for any cultural resources that are discovered. If that is not the case, other mitigating measures would have to be considered.



ALTERNATIVE 1
NO ACTION

WATERSHED

Watershed conditions and/or trends would not change from the existing situation, since this alternative would require continued management at current levels. Efficient and timely maintenance to structures/systems would provide continued detention of flood runoff at present levels. The capability of these structures/systems to store significant quantities of sediment is projected from now until 2004. Channel conditions may improve slightly but would probably stabilize since there would be no additional detention structures/systems placed in the basin. Once maintained, the water spreading dike systems would improve their detention and water spreading capabilities. Currently, these systems are in poor condition and complete maintenance would greatly improve their conservation effectiveness.

VEGETATION

The amount of herbage produced in the basin would remain relatively constant with this alternative. Its possible there would be a slight increase in herbage production depending on the design of the maintenance projects, but this possible increase would not be significant.

There would be no impacts on range condition.

GRAZING MANAGEMENT

With continued management, all structures would be maintained so there would be no impacts on livestock water. The numbers of high, medium and low value reservoirs for livestock (see Table 2.3) would remain the same.

WILDLIFE

This alternative would produce no change in wildlife populations or values. There may be minor fluctuations in wildlife populations as structure maintenance lagged or increased in response to budgets, but the overall impact would be insignificant.

RECREATION AND ACCESS

Recreation use and access would remain the same.

AESTHETICS

The aesthetics of the area would remain the same.

ECONOMIC CONDITIONS

There would be no change in ranch related economic conditions, watershed, wildlife or recreational economic benefits with this alternative. The present value of benefits from the existing structures is $200,000 (see Table 2.3 and Appendix 3.2). The only benefits quantified are watershed and wildlife related. The cost for maintaining the existing structures for the next 50 years would be approximately $2.59 million or $259,000 per year over a 10 year maintenance period 1986 to 1996. The present value of these costs is $1.62 million for a net present value (benefits minus costs) of $-1.42 million (see Appendix 3.2).

Maintenance and reconstruction of the existing structures would generate business activity and employment for the regional economy. Annual expenditures of $259,000 would generate other business activity in excess of $225,000, providing employment for nine workers and earnings of about $159,000 (see Table 4.1). These benefits would occur over the 10 year period 1986 to 1996 and would be insignificant to the regional economy.

SOCIAL CONDITIONS

Since this alternative would involve no change from the present situation, no change in social conditions would occur.

TABLE 4.1: ANNUAL REGIONAL ECONOMIC IMPACTS FROM MAINTENANCE AND RECONSTRUCTION CONTRACTING EXPENDITURES BY ALTERNATIVE FOR 10-YEAR MAINTENANCE PERIOD 1986-1996 (1984 Dollars) [1]

	Alternative			
	1	2	3	4
Contract Costs	$ 225,000	$ 90,000	$ 485,000	$ 215,000
Other Costs [2]	34,000	14,000	104,000	56,000
Other Business Activity	225,000	90,000	507,000	230,000
Total Business Activity	$ 484,000	$ 194,000	$1,096,000	$ 501,000
Employment (work years)[3]	9	4	21	9
Earnings	$ 150,000	$ 60,000	$ 332,000	$ 149,000

[1] Business activity, employment and income were calculated using coefficients from the BLM Montana Economic/Demographic Model.

[2] Includes survey and design costs and flood routing study.

[3] One work year is the equivalent of 12 months of full time employment.

ALTERNATIVE 2 ABANDONMENT (Proposed)

WATERSHED

Since this alternative proposes no further maintenance to the structures/systems, it is expected that over time, runoff and sediment control would be lost. It is difficult to estimate the timing and sequence of structure/system loss, since storm occurrence would be a principal agent in causing these structures/systems to fail.

With this alternative, during the life of this plan (50 years), it is expected that a majority of structures/systems would lose nearly 100% of their effectiveness in runoff detention and sediment storage. This statement is based on the observed rate of decline, due to lack of maintenance, of the various structures/systems. For analysis purposes, all structures/systems and their combined effects on runoff and sediment yield would be almost nonexistent by the year 2035.

A structure can fail when flood storage is exceeded, and rapid losses of soil erode the compacted fill dam or earthen spillway. Complete failure or breachment occurs when eroded dam or spillway elevations equal the original channel elevations. Failures cause water and the sediment contents of reservoirs to rapidly flow downstream. Localized impacts of failures would often be the appearance of deep incised gullies and nearby channel alterations from above normal scouring and deposition.

The Bureau of Land Management (BLM) estimates impacts at the mouth U.S. Geological Survey (USGS gage) and below to be minimal from the failure of one or a few structures/systems. However, the cumulative impacts of failures over time would be negative. Using the flood modeling program discussed in Chapter 3, the simulation of a 100 year storm event and elimination of all structures/systems (no detention effects) were computed. Results of the simulation indicate that a 100 year peak discharge at the USGS gage station would increase by 79% from the existing situation. This flood peak could potentially flood approximately 2,200 acres or about 12% of the Milk River 100 year flood plain delineated in the Soil Conservation Service (SCS) Flood Plain Management Study (Dept. of Agriculture). The mass failure of many structures/systems and its impacts were not analyzed due to the low probability of this event occurring.

Increased sediment yields and channel erosion would be the result as the number of failures continues to increase. It is estimated that almost no sediment storage capability would exist within 10 to 15 years. Sediment yields from the basin, due to the absence of retention capabilities, could be increased by as much as 55% (Frickel, 1972). Basin gradients and channel widths would be noticeably increased by 2035.

This alternative would have some negative impact on the overall watershed condition in Willow Creek and its drainage. Since this plan involves only channel controls, the impacts basin-wide may be less significant if upland watershed objectives would be applied through other forms of activity planning.

VEGETATION

The amount of herbage produced on the water spreader systems would decrease from 2,328,000 pounds to 776,000 pounds over the life of the plan. The most significant impacts would be on the Lone Tree allotment (Triple Crossing W.S.) and on the Lewis Reservoir allotment (Archambeault W.S.). This loss would be mitigated by planting grass on the reservoirs.

Range condition could decline in the Lewis Reservoir and Lone Tree allotments if the grazing systems were not modified. The chiseling and seeding should mitigate for the lost forage but use patterns could cause a decline in range conditions on these two allotments. The overall range condition would decline because the water spreaders take up the majority of a single pasture, causing increased grazing use on the uplands and a subsequent drop in condition on these uplands.

GRAZING MANAGEMENT

There would be a slight impact on the number of stockwater reservoirs available under this alternative. The current number of high and medium value reservoirs, 12 and 14 respectively, would decline to 5 reservoirs in each category. Those combined 10 reservoirs have an estimated life span longer than the life of the plan. The loss of the other 16 reservoirs would require the construction of 7 pits or small retention reservoirs but would be an insignificant impact on livestock.

WILDLIFE

It would not be practical to mitigate the wildlife habitat lost with total abandonment. This is because the wildlife values are tied so closely to the higher water table and/or available surface water of the structures. In other words, the only way to mitigate the wildlife losses would be to build additional reservoirs, which would defeat the purpose of this alternative.

The wildlife population changes would be subtle in the short term, but at the end of 50 years all the structures would be either of low or nonhabitat value for wildlife. These population changes are purely professional judgement and are meant to characterize changes, not to quantitatively measure variations.

Big Game

Mule deer and antelope populations would decline in the long term. This response would not be immediate because some structures and their residual benefits should last many years and because these structures provide important, but not critical, wildlife values. Therefore, even if all the structures were lost at once, the deer and antelope populations would not decline immediately, although some minor distributional shifts might occur.

Over a 50 year period, mule deer and antelope numbers would probably decline about 10%, which would be locally significant.

Upland Game Birds

Due to the heavy dependence of grouse broods on forbs, a significant population reduction could be expected with this alternative.

Contour furrowing is proposed as abandonment mitigation on four water spreaders and could adversely impact sage grouse habitat in the short term. While the bird populations would probably not respond measurably to these treatments, the furrowing would have to be limited to comply with the Missouri Breaks Environmental Impact Statement (EIS) objectives for the protection of sage grouse habitat, (at least on those spreaders within the EIS boundary). By the end of the long term, sage grouse densities could be reduced as much as 20%, which would be locally significant.

Waterfowl

During the short term, losses of habitat parcels would occur as structures failed or filled with sediment. While the birds, other than broods, using a specific reservoir don't perish when it dries up, they are certainly displaced and subjected to more stress while finding other habitat. The loss of the habitat on a given reservoir may not be significant itself, but the cumulative impact over many years of such occurrences could be major. Waterfowl numbers would probably be down by nearly 70% at the end of the long term, which would be locally significant.

Riparian Habitat

In the long term riparian habitat would shrink from its present acreage. As with other habitat values it would take many years for this to occur due to some existing structures having projected life spans in excess of the long term of this plan. Another reason for this delayed result is that dams and dikes tend to retain some high water table characteristics even after these structures failure.

Threatened/Endangered

At the end of 50 years the prey base for migrating bald eagles would be reduced due to lower waterfowl numbers. However, there would still be more than adequate prey for the number of bald eagles presently using the area.

RECREATION AND ACCESS

This alternative recommends abandonment of all structures and rerouting the high use roads. The amount of use received was the primary criteria for determining which roads or vehicle tracks would be rerouted. High values were placed on roads that are used constantly. Moderate on those exhibiting some use and low for vehicle ways that have not received a lot of use. Refer to Appendix 2.1C for methodologies and individual ratings per structure or system. Moderate and low use roads would not be maintained.

The Beaver Branch and TC access roads would be rerouted and/or maintained in accordance with the Valley Management Framework Plan. Those roads/vehicle ways receiving moderate or low use would continue being used, but would not be maintained. As dams with moderate to low access routes breach, their respective drainage crossings would be abandoned.

Recreation use would probably decrease slightly. The abandonment of some medium to low use roads/vehicle ways could cause a decline in vehicle access as nature takes its course. Eventually as much as 300 miles of these roads/vehicle ways could be lost within the basin. Big game hunting would decrease by 130 recreational visitor days (RVD), upland game by 40 RVD, and waterfowl would decrease by 110 RVD's.

AESTHETICS

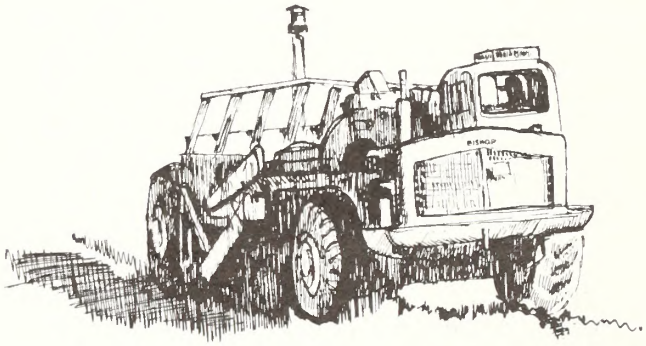
As various structures/systems breach, the aesthetics of the area would decrease. Most dams leave deeply incised stream channels when they breach, which create unsightly appearances.

ECONOMIC CONDITIONS

Over time the deterioration of the existing structures/systems would decrease economic benefits from reduced flood control of agricultural lands, lower sediment reduction, reduced wildlife habitat and subsequently recreation use. In the long term, all existing economic benefits associated with the watershed structures would be lost. The present value of benefits over the 50-year period is $136,000 (see Table 2.3 and Appendix 3.2).

An economic risk is being taken with this alternative due to reduced flood control of downstream agricultural lands. In the long term a 100 year storm could flood an estimated 2,200 acres of agricultural lands causing an estimated $177,000 loss in marketable commodities. This loss would impose an economic hardship to affected individuals.

Expenditures for mitigation costs of abandonment would generate some business activity and employment for the regional economy. Annual expenditures of $104,000 over the next 10 years would generate other business activity in excess of $90,000, providing employment for four workers and earnings of about $60,000 (see Table 4.1). These benefits would occur over the 10 year period 1986 to 1996 and are insignificant to the regional economy.



SOCIAL CONDITIONS

No change in social conditions would occur since this alternative would not create significant changes in employment and income. In the long term this alternative may produce some negative attitudes toward BLM since private agricultural lands could be flooded due to the abandonment of all existing watershed structures. This level of flooding would not currently threaten any type of buildings. However, any level of flooding could impose an economic and social hardship to affected individuals.

ALTERNATIVE 4 PRIORITIZED STRUCTURE/ SYSTEM MANAGEMENT

WATERSHED

All structures/systems proposed for abandonment under this alternative have a low watershed value. This statement is based on the use of flood modeling and a rating system described in Appendix 2.1A. By abandoning ineffective structures/systems, the overall watershed conditions and trends should remain the same.

A process of elimination, as explained in the methodologies section of Appendix 2.1A, would allow 40 structures/systems to be abandoned without significantly increasing flood peak discharges. Model results show an 8% increase in 100 year return frequency peak discharge from the existing situation. Because of this small increase, downstream flooding would not change the potentially flooded acres which exist at this time. Those acres fall between elevations which mark the zero damage zone (Dept. of Agriculture, 1984).

To avoid the risk of abandoning structures/systems above other key structures/systems, the watershed rating process accounted for this type of event. Localized impacts from failures (due to abandonment) can be dramatic with the appearance of deep incised gullies and nearby channel alterations from above normal scouring and deposition. This condition would remain localized, and should not impact the function of larger downstream control structures/systems. If selected, the implementation of this alternative would require careful review of abandonments during the site specific survey and design process. The use of a calibrated flood model would be advantageous in reducing downstream risks.

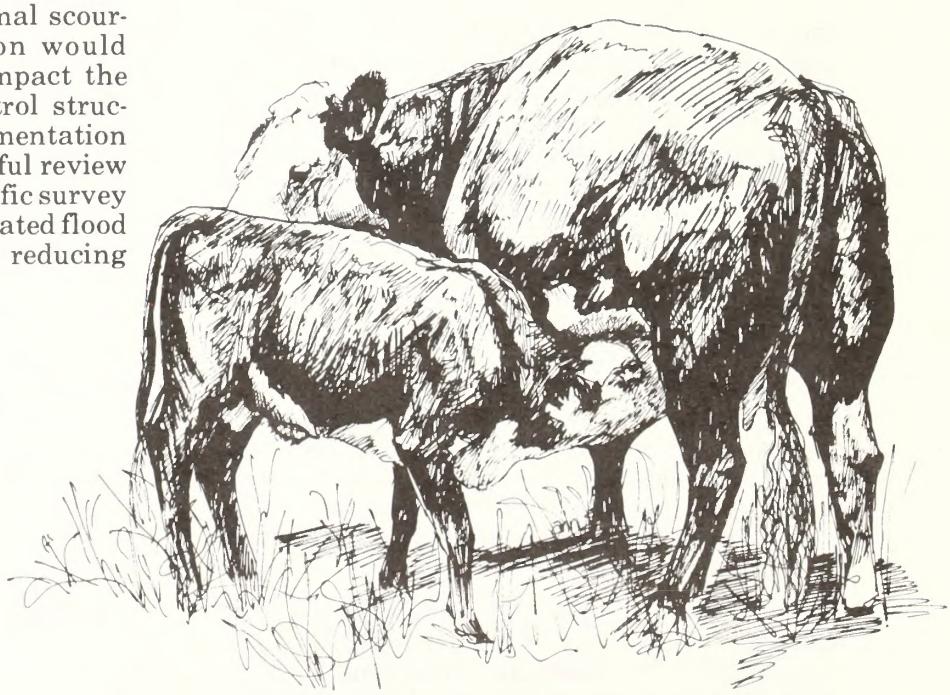
Based on the flood analysis for this alternative, sediment yield and the channel erosion impact would be insignificant. However, because of the abandonments, these parameters would increase slightly and negatively impact the watershed resource. The proposed abandonment would reduce existing sediment storage capability. It is estimated that 230,688 tons of sediment would be stored annually for 20 years. Channel conditions below structures/systems may show slight declines in condition, especially in areas where abandonment and consequential failures occur.

This alternative would not have a significant impact to overall watershed conditions. These impacts would be slightly negative since several structures would fail and small increases in peak discharges would occur.

VEGETATION

Herbage production would decline by 642,400 pounds over the entire basin because of production lost in the water spreader systems. The decline would not impact the individual allotments.

No impacts would be expected to range conditions under this alternative.



GRAZING MANAGEMENT

The impacts on livestock would be insignificant with this alternative. The impacts on livestock water would be very small on 13 reservoirs in the high category and 12 reservoirs in the medium category. With this alternative there would be a gain of one reservoir in the high value category and a loss of two reservoirs in the medium category.

WILDLIFE

With this alternative wildlife is affected by the abandonment action. Watershed proposed abandonment of 33 dams and 4 dike systems, of which wildlife values are medium for 6 dams and high for 4 others. The projected life span of some of the proposed abandonments exceeds the long term of this plan and, therefore, negates the wildlife impact of the abandonments on four medium value and one high value reservoir.

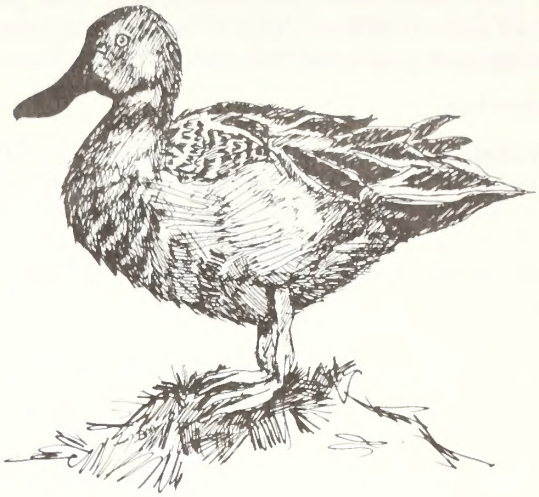
When compared to the existing situation this alternative generates some minor shifts among the various rating categories but produces no significant change overall (see Table 2.3). The only species group that may be impacted is waterfowl.

Big Game

There would be no measurable impact from this alternative on big game populations. The abandoned facilities would make no difference in the short term. Over the long term, big game would derive less from or lose the use of 10 reservoirs and 4 water spreaders that currently exist. While this may affect some local groups, it would not influence the basin-wide big game populations.

Upland Game Birds

Upland game birds would be impacted much the same as big game, i.e., some minor impacts on local populations but no substantial short or long-term changes. The contour furrowing proposed for the Triple Crossing Spreader Dikes would have to be limited to protect sage grouse habitat.



Waterfowl

The net result of this alternative would be positive for waterfowl even though some originally proposed wildlife improvements, (islands, capacity increases and pits) would be lost due to structure abandonment by watershed. Three of the abandoned reservoirs, Gravel Hill, Half Pint and Wagon Wheel, have sufficient habitat potential to justify wildlife assuming responsibility for them through other management actions. Four others are essentially saved due to having a life span that exceeds the plan period. The end result is the loss of only 3 dams out of 19 recommended for wildlife improvement. Three water spreaders are proposed for development and none of those were abandoned.

Waterfowl populations should increase because of the habitat enhancement projects, in spite of the structure abandonments. Ducks and geese should multiply by about 5% in the short term and 20% over the long term.

Riparian Habitat

Riparian vegetation would respond the same as in Alternative 3 for basically the same reasons, but the level would be lower. The loss of structures through abandonment would reduce the area's riparian potential. As mitigation for this loss of wildlife habitat, about 1 mile of fence would be built to protect approximately 30 acres of high potential riparian habitat. Vegetation developing within the exclosure would significantly extend an already valuable riparian zone. Riparian habitat would increase slightly in 10 years and moderately in 50 years.

Threatened/Endangered

The prey base would increase less in this alternative than in Alternative 3, but the net impact on eagles or potential falcons would be zero.

Fisheries

Fisheries would be impacted same as in Alternative 3. There would be even less opportunity for new, short-lived fisheries since fewer reservoirs would be increased in capacity. There would be no effective change from the existing situation.

RECREATION AND ACCESS

Recreation use would probably remain much the same. Waterfowl hunter use should increase by 30 RVD's. Enhancement of the structures that exhibit high multi resource values would probably increase general hunting opportunities. Conversely abandonment of low value structures could effect access, by decreasing some opportunities (see Appendix 2.1C).

Accessibility to Willow Creek would change slightly under this alternative. Less than 5 miles of roads would be lost since most abandonments in this alternative are reservoirs without roads. Roads of high value would continue to be open and maintained. Roads of moderate or low value would not be maintained, if the related structure/system is to be abandoned. This would depend on the watershed proposals under this alternative.

AESTHETICS

Aesthetics of the Willow Creek Basin should be enhanced. Structures of high use and value would be improved, offering more riparian and water retention. However, those structures of moderate or low value aesthetics would be degraded. Most dams when breached would cause deep incisive undercutting, leaving unsightly scars through the plans life span.

ECONOMIC CONDITIONS

There would be no significant change in ranch related economic conditions. In the short term, there would be no change in watershed, wildlife or recreational economic benefits. With modifications for resource values economic benefits associated with wildlife and recreation would increase slightly while benefits from sediment reduction would decline. The present value of benefits is $190,000 (see Table 2.3 and Appendix 3.2). The total cost for maintenance and modifications is $2.71 million or $271,000 per year over a 10 year period 1986 to 1996. The present value of these costs is $1.7 million for a net present value (benefits minus costs) of $-1.51 million (see Appendix 3.2).

Maintenance and modification of existing structures would generate business activity and employment for the regional economy. Annual expenditures of $271,000 would generate other business activity in excess of $230,000, providing employment for nine workers and earnings of about $149,000 (see Table 4.1). These benefits would occur over the 10 year period 1986 to 1996 and are insignificant to the regional economy.

SOCIAL CONDITIONS

No change in social conditions would occur, since this alternative would involve insignificant changes in employment and income.

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APPENDICES

APPENDIX 1.1
PERMITTEE QUESTIONNAIRE

1. Should the BLM maintain the detention dams in your allotment? If so, which dams and why?

2. Would the BLM maintain the spreader dike systems in your allotment? If so, why?

3. Should the BLM build additional watershed projects in your allotment (i.e., detention dam, spreader dike, contour furrowing)? If so, where and why?

4. Do you have any other comments on the management of the watershed in your allotment?

_____ _____

Signature Date

APPENDIX 2.1
PROCEDURES AND RESOURCE VALUE RATINGS FOR:

A. Watershed

B. Wildlife

C. Access

D. Grazing Management

APPENDIX 2.1A
WATERSHED

A flood routing model with the aid of a computer was used to assess watershed values of individual reservoirs and water spreading dike systems. The U.S. Geological Survey (USGS) coordinated and conducted this modeling effort through an interagency study agreement with BLM. Watershed values are based entirely on 100-year return frequency storm runoff. Peak discharges and flow durations were the dependent variables used in assessing values of structures/systems in detaining storm runoff. Since those variables are directly and proportionally related to flood volumes, channel erosion and sediment yield, then they were used to rate each structure's/system's watershed value.

The U.S. Army Corps of Engineers HEC-1 Flood Hydrograph Package was used to quantitatively describe hydrologic variables. The program essentially routes storm runoff throughout the basin. Beginning with precipitation and runoff components, the program then combines channel and reservoir components downstream to produce a flood discharge at every point in the basin. The last point that streamflow is routed through is the USGS stream gage located at the mouth of the planning basin. The modeling process is intricate and complicated, and provided BLM with hydrographs, peak discharges, runoff volumes and flow durations. A more in-depth understanding of the model and its inputs/outputs is available by referring to the Corps of Engineers' HEC-1 Users Manual.

The HEC-1 model was selected because of its diversity in simulation options relative to other flood routing models. Some benefits afforded by this model are listed below:

a. Flexibility in generating synthetic storm distributions.

b. Calculations of precipitation loss based on Soil Conservation Service curve number. This number is based on range sites and soil units, both of which had been extensively inventoried in the Willow Creek Basin area. Curve numbers will eventually be used as a calibration device in modeling Willow Creek.

c. By using a hydrograph interpretation process the model can make calculations in a complex river or stream basin such as Willow Creek.

d. For future assessments, and once calibrated, a flood damage analysis option will allow an economic assessment of flood risks.

The BLM provided some input data used in this modeling process. Reservoir stage-capacity tables were developed by surveying each reservoir. Reservoir surveys were performed while coordinating with the USGS. Surveys included measurements of maximum depth, spillway cross-sections, elevations of all outflow pipes and permanent markers, and pool depths where retention storage was encountered. Reservoir surface areas were planimetered and referenced to a known elevation. This information was used to compute storage volume versus elevation relationships using a conical volume method described in HEC-1 Users Manual.

Range site curve numbers were derived by the Agricultural Research Service (ARS) for range sites in northeastern Montana. The ARS curve numbers were applied to range sites and soil units in the Willow Creek Basin. This mapped information was available due to recent BLM soil and range inventories. Curve numbers were weighed according to distributions of range sites within a sub-basin, and the sub-basin curve number was used as input to the model.

Channel capacity information, needed for modeling, was compiled from surveys of channel cross-sections throughout the basin. A range of several varying cross-sectional areas was developed from survey information. This set of cross-sectional areas then became the basis for input to the model.

The information described so far was only part of a considerable larger amount of inputting and modeling. Additional information pertaining to this effort (i.e., other input parameters, output format, etc.) is available in the Lewistown District Office and HEC-1 Users Manual.

Model verification was performed by comparing output data to a regional peak discharge versus drainage area relationship. A rainfall depth-area adjustment provided a reasonable fit on the regional plot. This adjustment accounted for the higher probability of convective thunderstorms being the primary flood causing precipitation event. Verification was done using no storage effects in the Willow Creek Basin. An analysis of input variables sensitivities in altering output products showed curve number to be highly sensitive. Further modeling, using collected field data such as storm runoff and precipitation, will indicate accuracies of curve numbers used.

Computer runs were done by adding and deleting storage effects caused by reservoirs and dike systems. With all current storage effects considered, seven key structures/systems were selected. Criteria for selecting key structures/systems included a reduced onsite flood peak discharge by at least 30 to 40%, and a location occurring on one of the major tributaries. These key structures/systems follow: Triple crossing, Gutshot, Grub, Mudpot, Forest, Collins Reservoirs; and Archambeault Dike system.

The key structures, once selected, remained in place during additional runs. A process of elimination of those structures/systems contributing least to flood peak attenuations was completed. Through this process 43 reservoirs and 5 dike systems could be eliminated without causing significant increases in flood peak discharge at the basin mouth (a 7.8% increase in discharge).

Before relating findings to values of individual structures/systems, these eliminations and their relationships to key structures had to be evaluated. Thirty-nine reservoirs and two dike systems which had potential for elimination are located above key reservoirs. If their elimination caused significant increases in inflows to respective downstream key structures, then they could not be eliminated. This analysis was applied, and the results reduced elimination sets to 37 reservoirs and 5 dike systems. Upon further evaluation due to structure's/system's importance in studies and dike system effectiveness (i.e. a reservoir which drops or places water into a dike system), a final elimination set of 35 reservoirs and 4 dike systems was completed.

Table 1 shows watershed values assigned to individual structures/systems. The values are results of HEC-1 modeling. Those structures/systems marked with an "A" for abandonment were identified in the final elimination set. Low, medium and high values marked with L, M and H, respectively, correspond to their significance on flood peak attenuationat their particular location within the Willow Creek Basin. High value structures/systems were primarily those identified as "key" earlier in this discussion. Only existing values were assigned to structures/systems.

TABLE 1: RESOURCE VALUES

Structures/Systems	JDR No.	Watershed Existing	Wildlife Existing	Wildlife Potential	Livestock Mgt. Existing	Livestock Mgt. Potential	Access Existing
1. Tomahawk Det. Dam	0770	A	L	M	L	H	H
2. Grub Det. Res.	07B9	H	H	M	H	H	H
3. Upper Lone Tree Det. Rea.	0811	L	A	H	H	H	L
4. Brazil Divide Det. Res.	0814	A	L	H	L	L	L
5. Beaverette Oet. Res.	0816	A	A	M	L	H	L
6. NW Burnett Det. Res.	0817	L	A	H	L	H	L
7. Lower Burnett Headcut Det. Res.	0818	H	L	H	H	H	L
8. SW Burnett Det. Res.	0819	M	A	H	L	H	L
9. Bugle Det. Res.	0821	A	A	A	L	L	L
10. Hamms Det. Res.	0869	M	M	H	H	H	H
11. N. Beaver Det. Dam	0870	A	A	M	L	L	L
12. Hurricane Det. Res.	0871	L	H	H	H	H	L
13. Moccasin Det. Res.	0872	L	A	H	L	L	L
14. Beechnut Det. Res.	0874	A	A	L	L	L	L
15. Mokee Oet. Res.	0876	A	L	H	L	H	L
16. Alkali Det. Res.	0877	M	A	H	L	L	L
17. Tepee Det. Dam	0878	A	A	M	L	L	L
18. Badger Det. Dam	0879	H	L	M	M	H	L
19. Judy Oet. Dam	0895	A	A	H	L	M	H
20. January Det. Res.	0896	H	M	H	M	M	H
21. Deep Cut Det. Rea.	0897	H	L	H	L	H	H
22. Blanchard Det. Res.	0898	H	A	M	L	A	L
23. Big Forks Det. Dam	0899	H	A	M	L	L	L
24. TC Drop Dam	1073	L	M	M	M	H	L
25. Jim Det. Dam	1085	H	M	M	H	L	H
26. Gutshot Det. Dam	1086	H	M	M	H	H	H
27. Pearson Det. Dam	1087	L	A	M	L	A	L
28. Dog Creek Det. Res.	1097	A	A	H	L	A	L
29. Bomber Oet. Res.	1098	H	A	M	L	H	L
30. Rinnie Det. Res.	1099	M	A	M	L	M	L
31. Archambeault Det. Res.	1116	M	A	M	L	H	L
32. Skeeter Det. Dam	1118	A	A	M	L	L	L
33. Target Oet. Oam	1119	H	A	M	L	L	L
34. Lori Det. Dam	1120	L	A	H	L	A	L
35. Gravel Hill Det. Res.	1121	A	M	H	M	L	L
36. Half Pint Det. Dam	1122	A	M	H	H	M	L
37. Corral Junction No. 1 Det. Res.	1125	A	A	H	L	H	L
38. Skull Oet. Res.	1126	A	H	H	H	L	L
39. Your Name Det. Res.	1127	A	A	H	L	M	L
40. Three Tree Det. Res.	1128	M	L	H	M	L	L
41. Cottonwood Det. Res.	1129	M	L	H	L	H	H
42. Corral Junction Det. Res.	1131	M	A	H	L	L	L
43. Corral Junction Ext. Oet. Res.	1135	A	A	H	L	H	L
44. Tin Roof Det. Res.	1136	A	L	M	L	H	L
45. Dne Fork Det. Res.	1137	M	A	H	L	A	L
46. Hard Pan Det. Res.	1138	L	L	M	H	L	M
47. Sheepshed Det. Res.	1139	L	A	M	L	A	L
48. Camp Det. Res.	1140	L	A	M	L	A	L
49. Mudpot Det. Dam	1162	H	H	M	L	H	L
50. Desert Det. Res. (Private)	1164	A	H	H	L	A	L
51. Short Creek Det. Res.	1166	A	A	H	L	M	L
52. Upper S. Fork Oet. Dam	1169	L	L	M	L	H	L
53. Two Fork Det. Res.	1178	L	H	H	H	H	L
54. Chico Flats Det. Res.	1179	A	A	M	L	A	L
55. Collins Det. Res.	1182	H	H	H	L	A	M
56. Forest Det. Res.	1183	H	H	H	L	L	L
57. Half Barrel Det. Res.	1195	M	A	H	L	H	L
58. Cactus Flat Oet. Oam	1199	H	M	H	L	L	L
59. Itcaina Oet. Res.	1202	H	M	M	H	H	H
60. S. Beaver Det. Res.	1203	H	A	H	L	M	M
61. Script Det. Res.	1204	A	A	M	L	M	L
62. Arrambide Oet. Res.	1205	L	M	H	M	L	M
63. Browning Det. Res.	1214	L	L	M	L	A	L
64. Whitetail Det. Dam	1216	A	M	M	M	M	H
65. Ruins Det. Dam	1218	A	H	M	H	H	L
66. Fawn Drop Dam	1219	A	L	H	L	H	L
67. Clover Drop Oam	1220	A	L	L	H	A	L
68. Nod Det. Oam	1221	L	L	L	L	H	L
69. Bend Oet. Dam	1222	L	M	H	H	H	L
70. Foulweather Det. Dam	1224	A	L	H	M	H	M
71. Hard Rock Det. Dam	1226	M	L	M	M	H	M
72. SDB Det. Dam	1227	A	M	M	M	L	L
73. Horny Det. Dam	1228	A	L	M	L	M	L
74. ULT Det. Dam	1229	A	M	H	L	H	M
75. Double Crossing Det. Dam	1239	A	A	M	L	H	L
76. Dead Horse Det. Oam	1240	A	A	M	L	M	H
77. Twin Forks Det. Dam	1241	A	A	M	L	M	L
78. Tripple Crossing Det. Dam	1242	H	L	M	L	H	H
79. Finale Det. Dam	1326	A	H	M	H	H	H
80. Willow Flat Det. Dam	7262	L	L	M	L	A	L
81. Willow Cr. Det. Res.	1080	L	A	M	L	H	L
82. Willow Flat Div. Res.	6879	L	A	M	L	H	L
83. Wagon Wheel Det. Res.		A	M	H	L	A	L
Water Spreading Facilities							
1. Burnett W.S.	0792 & 0793	H	H	H	H	H	L
2. Brazil Divide W.S.	0813	A	L	H	M	M	L
3. Beaverette W.S.	0815	A	L	M	M	H	L
4. Lone Tree W.S.	0823	A	A	L	L	M	L
5. Archambeault W.S.	1102	H	L	L	H	H	H
6. Bomber W.S.	1103	A	A	L	M	H	L
7. Cactus Flat W.S.	1200	H	L	M	H	H	M
8. Tripple Crossing W.S.	1259, 1260, 1261 & 139D	H	M	H	H	H	L
9. Dog Creek W.S.	1D83	H	L	M	H	M	L

A - Abandon
L - Low
M - Medium
H - High

APPENDIX 2.1B
WILDLIFE

Each of the watershed stuctures were evaluated in the field, and/or in the office for wildlife habitat value.

The field examination consisted of checking a structure either by truck or all-terrain cycle. The facility was thoroughly covered so that all its aspects and features could be viewed. This method was generally used on dams and spreaders that the biologist had never inspected previously or had only limited knowledge of.

The office evaluations were done with the aid of aerial photography, past or present field notes and professional knowledge of the area. Many of the structures had been examined numerous times in the past during wildlife surveys or habitat development work; the biologist was thoroughly familiar with their characteristics and potentials.

On both types of evaluations a form was completed (see Tables 2 and 3). Habitat parameters such as structure size, depth, topography, vegetation, water quality and quantity, wildlife use, etc., were recorded. A drawing was made of the reservoir or dike which included any recommended habitat developments. Key wildlife species were censused and waterfowl were classified, if possible, to species, sex, and broods. A rating of the structure's present, overall wildlife value was made. If the structure was in need of maintenance, the rating reflected what the value would be if necessary repairs were made. An estimate of potential addressed the impoundment value after modifications for wildlife benefit. Rating were made for total wildlife values with waterfowl habitat components being the most heavily weighed, although a few reservoirs without waterfowl habitat received high scores due to overriding riparian or upland values. Subjective habitat ratings of high, medium and low value were used for both existing and potential categories. A fourth rating "abandon" was used which indicated nonhabitat and that, under the given situation or alternative, no expenditures for wildlife are justified on the facility. These ratings were derived roughly as follows, although some variations were made due to professional judgment:

Parameters
- waterfowl habitat
  - size (surface-acres)
  - capacity
  - water quality
  - vegetation (emergent/submergent/shore)
- big game and upland gamebird habitat
- riparian vegetation

Values
- High: usually two or more parameters rated good or better
- Medium: at least one parameter rated good or better
- Low: majority of parameters fair or poor
- Abandon: all parameters, or the key parameter, poor.

Refer to Appendix 2.1A; Table 1 for existing and potential ratings of all projects.

TABLE 2: WILLOW CREEK INTERDISCIPLINARY WATERSHED ACTIVITY PLAN

6/5/84

RESERVOIR EVALUATION

—Wildlife—

No./Name _____ Date _____ Evaluator _____

Location: Allot. _____ Section _____ Township _____ N. Range _____ E.

PHYSICAL DATA

Project Marker ____ Yes ____ No

Size (acres)
- 0 — 1 _____
- 1 — 3 _____
- 3 — 5 _____
- 5 — 10 _____
- 10 — plus _____

Maximum Depth _____
% less than 2′ _____

Turbidity
- High _____
- Moderate _____
- Low _____
- Clear _____

Shoreline Slope
- Steep bank _____
- Medium slope _____
- Gentle slope _____
- Feather edge _____

Surrounding Topography
- Rough _____
- Rolling _____
- Flat _____
- Coulee _____

Water Source
- Runoff _____
- Springs _____
- Stream _____
- Other _____

Prominent Features
- Peninsulas _____
- Islands _____
- Other _____
- _____ _____

Grazing
- None _____
- Light _____
- Moderate _____
- Heavy _____

Water Level: Normal _____ Above _____ Below _____
Area of Watershed _____ Age _____

Seepage below dike _____

Fencing _____

Access _____

Condition of Dike _____
Current Recreation Use: Fishing _____ Hunting _____ Picnicking _____

VEGETATION DATA

Type: Sagebrush GL_____ Marsh _____ Meadow_____ Woody_____ Open_____ Prairie GL_____

Shoreline Vegetation			Important Species
Marsh	_____	%	_____
Meadow	_____	%	_____
Sagebrush GL	_____	%	_____
Woody	_____	%	_____
Cropland	_____	%	_____
Denuded beach	_____	%	_____
Other_____	_____	%	_____

Surface Vegetation (% of surface occupied)

Emergent	_____	%	_____
Submerged	_____	%	_____

WILDLIFE USE: Ducks _____ Geese _____ Pheasants _____ Huns _____ Sharptails _____
White-tailed deer _____ Mule deer _____ Antelope _____ Fish _____ Sage grouse _____

WATERFOWL COUNT:

TABLE 3: WILLOW CREEK INTERDISCIPLINARY WATERSHED ACTIVITY PLAN

6/5/84

WATER SPREADER EVALUATION

—Wildlife—

No./Name _____ Date _____ Evaluator _____

Location: Allot. _____ Section _____ Township _____N. Range _____E.

PHYSICAL DATA

Project Marker ____ Yes ____ No

Size (acres)
- 0 — 1 _____
- 1 — 3 _____
- 3 — 5 _____
- 5 — 10 _____
- 10 — plus _____

Maximum Depth _____
% less than 2′ _____

Turbidity
- High _____
- Moderate _____
- Low _____
- Clear _____

Shoreline Slope
- Steep bank _____
- Medium slope _____
- Gentle slope _____
- Feather edge _____

Surrounding Topography
- Rough _____
- Rolling _____
- Flat _____
- Coulee _____

Water Source
- Runoff _____
- Springs _____
- Stream _____
- Other _____

Prominent Features
- Peninsulas _____
- Islands _____
- Other _____
- _____ _____

Grazing
- None _____
- Light _____
- Moderate _____
- Heavy _____

Water Level: Normal _____ Above _____ Below _____
Area of Watershed _____ Age _____

Seepage below dike _____
_____

Fencing _____
_____

Access _____
_____

Condition of Dike _____
Current Recreation Use: Fishing _____ Hunting _____ Picnicking _____

VEGETATION DATA

Type: Sagebrush GL_____ Marsh _____ Meadow_____ Woody_____ Open_____ Prairie GL_____

Shoreline Vegetation			Important Species
Marsh	_____	%	_____
Meadow	_____	%	_____
Sagebrush GL	_____	%	_____
Woody	_____	%	_____
Cropland	_____	%	_____
Denuded beach	_____	%	_____
Other_____	_____	%	_____

Surface Vegetation (% of surface occupied)

Emergent	_____	%	_____
Submerged	_____	%	_____

WILDLIFE USE: Ducks _____ Geese _____ Pheasants _____ Huns _____ Sharptails _____
White-tailed deer _____ Mule deer _____ Antelope _____ Fish _____ Sage grouse _____

WATERFOWL COUNT:

APPENDIX 2.1C
ACCESS

Access value was determined by the necessity to ranchers, recreationists and Bureau of Land Management (BLM) employees. An inventory of structure use was completed with the help of Valley Resource Area (VRA) employees, aerial photo interpretation and field checks. All structures that were part of a maintained road were given a high access value. Structures with a definite trail crossing were given a medium rating. Structures without trails, or those lending no added access value were given a low rating. Dike system values were determined by their importance to adjacent roads. Structures were rated for their intrinsic value without regard of the importance of downstream structures.

APPENDIX 2.1D
GRAZING MANAGEMENT

The reservoirs were rated H, M, L according to how useful they were for livestock water and how important they were to the water spreader systems. Any reservoirs that provided season long stock water or directly diverted water into the water spreaders were rated high. If the reservoirs provided stock water to approximately July 15, they were rated M and if they only provided early spring stock water they were rated L.

The water spreaders were rated on the herbage production. If it was significant the spreaders were rated H.

The following table indicates ratings for existing and alternative situations:

H — High value
M — Provides water for part of the year
L — No livestock water provided

Refer to Appendix 2.1A; Table 1 for existing and potential ratings for all projects.

APPENDIX 2.2
STRUCTURE/SYSTEM MAINTENANCE PRACTICES

Replacing pipe involves excavation of the old pipe zone a minimum of 2′ below the designed bottom elevation of replacement pipe, with a minimum of 12′ bottom width and 3:1 side slopes to permit adequate bonding of replaced material. After removal of the old pipe and all appurtenances. A new pipe pad 2′ thick (minimum) is watered and rolled to enable installation of new pipe. New pipe and appurtenances are then installed and all earthen material placed at 95% maximum dry density to the lines and grades of the original structure.

At this time any deficiencies in freeboard, top width, wave action, damage or spillway function impairment due to sheet, gully or wind erosion are repaired.

The use of concrete for principal spillways was considered in this alternative. Presently, the cost and feasibility of using concrete seem to rule out this engineering option. However, at a later date this option may be practical on a case by case basis. The costs of concrete repairs are not included in this or any alternative (see the conclusion of this appendix for an analysis of this engineering option).

In cases of severe wave action damage slope protection may be necessary to prevent a dam from washing out. Restoration of the upstream slope with earthfill and placement of stone riprap is a common practice. Stone riprap is placed along the full length of the face of the dam extending above and below areas exposed to wave action. In extreme cases when stone riprap is either unavailable or economically unfeasible, other methods may be used.

Spillway repair involves restoring original lines and grades with earthen materials, slope and bottom protection with stone riprap, or relocation and reconstruction due to failure from sheet or gully erosion.

Cathodic protection involves the installation of anodes to extend the life of existing metal underground structures. Installation on existing projects involves welding or otherwise attaching a metal strap from one pipe segment to another to form a connected "circuit", with anodes buried along the side of the pipe. Electrons flow from the anode to the structure through a connecting wire, corroding the anode and not the pipe. This installation is only possible on existing structures with pipe large enough to allow workmen to enter pipe for the installation of a "circuit" strap. Since the anodes need periodic replacement they are placed in an area they can easily be accessed.

Concrete headwalls on the upstream end of pipes can crack away from the pipe and permit water to carry away underlying soil support. The weight of headwall then begins to bear upon pipe and results in pipe failure if not corrected. Repair usually involves removing the concrete headwall, placing stone riprap around pipe inlet and replacing the existing trash rack.

One exception to the maintenance described above would be a necessary redesign to the Triple Crossing (TC) system (excluding TC Reservoir). The system allows 46 square miles of the Lone Tree drainage above TC Dam to flow directly into the water spreader dikes. This flow not only produces a tremendous excess of water, but at times is sustained at a steady rate in excess of 30 days. These excessive, long duration flows damage vegetation and cause severe headcutting throughout the entire dike system. If not corrected, the dike system will become ineffective.

The maintenance prescribed for TC dikes includes realignment in order to spread runoff water from smaller side channel drainages. The larger discharges from TC Reservoir would bypass the system, thereby allowing shorter flow durations and less volume within the system.

CONSIDERATION OF CONCRETE DROP STRUCTURES

The principal spillways could also be replaced with concrete drop spillways. Concrete drops would have the basic function of dropping the water from an elevation behind the detention fill to a given elevation at the bottom of the drainage.

Design and cost of the drop structures would vary per site but the basics would be as follows. A concrete drop structure would have four basic sections: inlet, chute, stilling basin, and apron as shown on the concrete drop drawing, Figure 4.

Width of the structure would depend on the peak flow required to pass over the structure. Length of the chute would depend on the vertical drop that would be required for each site. Because of the changing width and length, the cost of the structure will also vary per site. As shown on Figure 5 the cost versus peak flow, versus vertical drop chart, the cost will increase as flow and drop increase. Cost for each peak flow can be taken from this chart.

Benefits of concrete drop:

1. Accessibility for maintenance when needed.
2. No maintenance for 50 years.
3. More resistance to chemical reaction than unprotected metal pipe.
4. Small volume of earthwork needed for installation and maintenance.

Disadvantages of concrete drop:

1. Large amount of labor needed for installation.
2. Foundation problems with types of soil in most locations of Willow Creek.
3. Elevation of retention water could be zero to very small.
4. Would need alternatives for access over fills that had drop structures (i.e., bridges or something would be needed for access).

FIGURE 1 CONCRETE DROP STRUCTURE

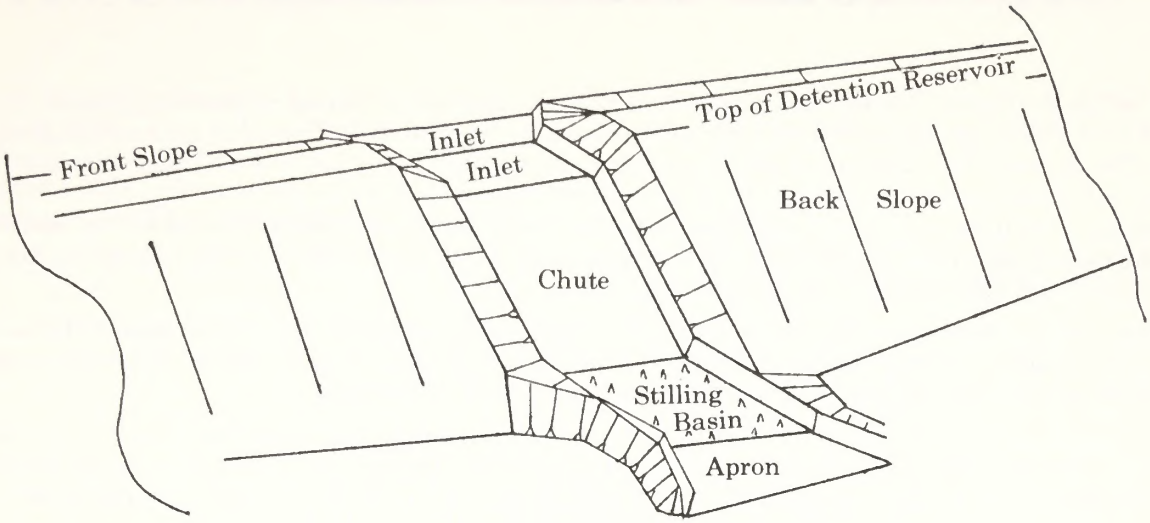
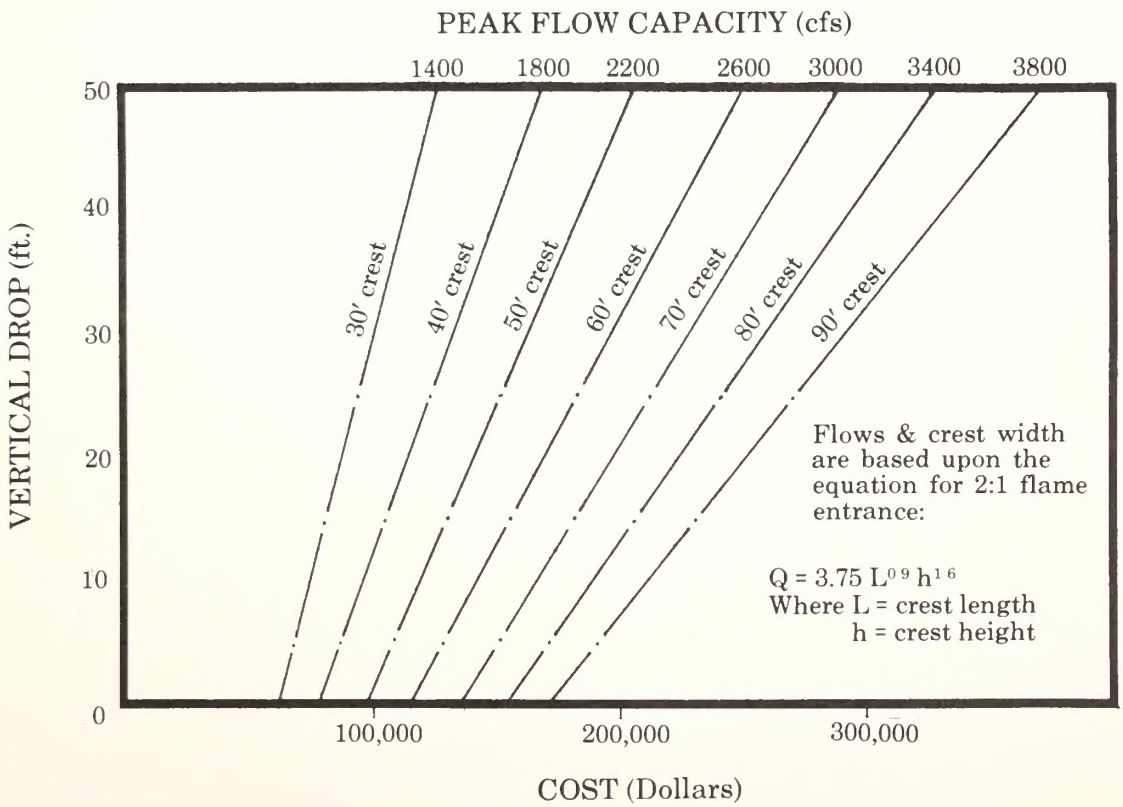


FIGURE 2. COST VS. VERTICAL DROP VS. PEAK FLOW CAPACITY



APPENDIX 2.3
STRUCTURE/SYSTEM MITIGATIONS

Rerouting a road as a mitigative action involves a new stream crossing located either upstream or downstream of the abandoned dam. New lengths of road and a bridge or culvert crossing are part of the engineering feasibility to be considered.

Small retention dams would replace livestock watering values lost by abandonment. Usually this type of a structure would be in the form of a 2 acre-feet pit reservoir. The BLM constructs many structures of this type to benefit its grazing management programs.

The livestock forage lost by abandoning some water spreading dike systems would be replaced by mechanically treating the area or adjacent uplands, and in some cases supplementally seeding the treated areas. This action would occur only in areas where topography and soils meet the proper criteria and provide good responses to treatment proposed under this alternative.

APPENDIX 2.4
STRUCTURE/SYSTEM MODIFICATIONS

Raising an existing structure involves placing earthen material along the full length of either the front or back of the dam with sufficient width to accommodate the desired slope, top width and crest height. The existing spillway is blocked or backfilled. A new spillway is located and constructed with a height and width sufficient for maintaining new water elevations expected from a specified design peak storm inflow. New spillways may be either natural or excavated.

If the existing structure to be raised has an outlet pipe, additional pipe must be attached to the upstream end. This would provide a hydrologically designed height and front slope to prevent ice damage to the riser pipe. Any disturbed appurtenances such as trash racks, vortex fins, stone riprap, fences, etc., must be removed, then properly replaced. Additional pipe must be attached to the downstream end of the pipe to accommodate new earthfill. Downstream appurtenances such as dissipators, gabions, stone riprap, etc., must be removed and replaced if applicable.

When related to the construction of raising a pipe, all existing roads, trails, powerlines, fences, or other developments to be inundated by higher water levels would be removed, relocated or abandoned.

New islands are frequently provided with slope protection using stone riprap or other materials to prevent wave action erosion. Proposed island construction may involve construction of islands using materials other than earth such as stone, bales, etc.

Island construction involves three basic types of construction.

Moat Island: A mound of elevated earth using earthen materials from around all sides, resulting in an island. There has to be a 4 foot minimum depth trench around the perimeter of the island.

Peninsula Island: A peninsula extending into a water pool is cut off from the mainland leaving an island. Excavated material from this operation is used to increase island height or to construct other islands.

Pit Islands: Islands are constructed from material removed from a measured borrow pit.

The small wildlife ponds proposed are similar to pit type reservoirs with the exception of being shallower and having more surface area. These ponds are associated with water spreading dike systems and are constructed during maintenance operations on a particular system. As a modification to a structure/system a livestock watering pit is constructed within the detention area of a dam or dike. During runoff events this pit is recharged. This access allows for a longer duration supply of water to livestock. The pits are constructed so that livestock access through muddy sediments is avoided.

APPENDIX 3.1
PHYSICAL PROPERTIES OF SOILS

APPENDIX 3.1: PHYSICAL PROPERTIES OF THE SOILS IN THE WILLOW CREEK BASIN (Cont'd)

Soil Name	Range Site	Cround Cover	Soil Depth Favor-able to Plant Roots	Natural Drainage Class	TEXTURE Surface Layer	TEXTURE Subsoil or Underlying Material	Permea-bility of Most Re-strictive Layer	Avail-able Water Capacity	Surface Water Runoff	EROSION SUSCEPTIBILITY Water Erosion Rating	EROSION SUSCEPTIBILITY Wind Erodibil-ity group (WEG)	Hydro-logic Soil Croup	Soil Loss Equation "K" Factor (Surface Layer)	Restrictive Soil Factors
Havre	Clayey	80-85	Deep	Well drained	Clay loam-loam	Loam-clay loam-fine sandy loam stratified	Moderate	High	Slow	Slight	Severe (4L)	B	.28	Wind erosion hazard; moderate compaction susceptibility
Mariss	Clayey	65-75	Deep	Well drained	Clay silty clay	Clay-silty clay	Slow	High	Slow-medium	Slight -mod-erate	Severe (4)	D	.37	Texture; permeabili-ty; wind erosion hazard; high compac-tion susceptibility
Neldore	Coarse clay	40-50	Shallow	Well drained	Clay	Clay over acid shale	Slow	Very low	Medium -very rapid	Moder-ate-high	Severe (4)	D	.43	Depth; high com-paction suscepti-bility; texture; permeability
Phillips	Silty	80-90	Deep	Well drained	Loam	Clay-clay loam	Very slow	High	Slow-medium	Slight -high	Moderate (5)	C	.43	Subsoil texture; permeability; high compaction susceptibility
Scobey	Silty	75-85	Deep	Well drained	Loam-clay loam	Clay-clay loam	Moder-ately slow	High	Slow-rapid	Slight -high	Moderate (6)	C	.32	Permeability; water erosion hazard on slopes; moderate compaction susceptibility
Sunburst	Thin clayey	60-70	Deep	Well drained	Clay loam	Clay loam	Slow	High	Medium -very rapid	Moder-ate-high	Severe (4L)	C	.37	Permeability; water and wind erosion hazard; moderate compaction susceptibility
Thebo	Clayey	50-60	Moder-ately deep	Well drained	Clay	Clay over shale	Very slow	Moder-ate	Medium -very rapid	Moder-ate-high	Severe (4)	D	.37	Depth; texture; permeability; water and wind erosion hazard; high compac-tion susceptibility
Vaeda	Dense clay	25-35	Deep	Well drained	Silty clay-clay	Silty clay-clay	Very slow	High	Slow-rapid	Slight -high	Severe (4)	D	.24	Texture; vesicular crust; permeability; high compaction susceptibility
Vanda	Dense Clay	25-35	Deep	Well drained	Clay-silty clay	Clay-silty clay	Very slow	High	Slow-rapid	Slight -mod-erate	Severe (4)	D	.24	Texture; vesicular crust; permeability; strongly alkaline; high compaction susceptibility
Julin	Clayey	50-60	Moder-ately deep	Well drained	Silty clay-clay	Silty clay -clay over shale	Slow	Low	Medium -rapid	Moder-ate high	Severe (4)	C	.37	Texture; permea-bility; water and wind erosion hazard; high compaction susceptibility

APPENDIX 3.1: PHYSICAL PROPERTIES OF THE SOILS IN THE WILLOW CREEK BASIN

Soil Name	Range Site	Ground Cover	Soil Depth Favor-able to Plant Roots	Natural Drainage Class	TEXTURE Surface Layer	TEXTURE Subsoil or Underlying Material	Permea-bility of Most Re-strictive Layer	Avail-able Water Capacity	Surface Water Runoff	EROSION SUSCEPTIBILITY Water Erosion Rating	EROSION SUSCEPTIBILITY Wind Erodibil-ity group (WEG)	Hydro-logic Soil Group	Soil Loss Equation "K" Factor (Surface Layer)	Restrictive Soil Factors
Shale	Rock Shale	0	None	None	Clay over shale	Shale	Very slow	Very low	Very rapid	High	Severe (4)	D	.64	Nearly barren shale; erosion hazard
Ustic Torrifluvents	Over-flow	80-85	Deep	Moderately well-well drained	Sandy loam-clay loam	Sandy loam -clay loam stratified	Moderate-moderately slow	High	Medium	Slight moderate	Severe (4L)	C	.32	Variable textures; subject to flooding; wind erosion hazard; dissected by stream channels; moderste compaction susceptibility
Absher	Claypan	70-80	Deep	Moderately well drained	Loam	Clay	Very slow	High	Slow-medium	Slight -moderate	Moderate (6)	D	.49	Claypan; texture, permeability; drainage; sodic soil; high compaction susceptibility
Cabbart	Shallow	60-70	Shallow	Well drained	Loam	Loam over bedrock	Moderate	Very Low	Slow-rapid	Slight high	Severe (4L)	D	.37	Depth; available water capacity; water and wiod erosion hazard; moderate compaction susceptibility
Delpoint	Silty	70-80	Moderately deep	Well drained	Loam	Loam over bedrock	Moderately slow	Moderate	Slow medium	Moderate-high	Severe (4L)	C	.37	Depth: permeability; moderate compaction susceptibility
Dilts	Coarse clay	25-45	Shallow	Well drained	Clay or silty clay	Clay over acid shale	Slow	Very low	Medium -very rapid	Moderate high	Severe (4)	D	.43	Depth; texture; permeability; high compaction susceptibility
Ellom	Claypan	60-70	Deep	Well drained	Clay loam	Clay-clay loam	Very slow	High	Slow-rapid	Slight -high	Moderate (6)	D	.49	Texture; permeability, high compactioo susceptibility
Harlem	Clayey	80-85	Deep	Well drained	Silty clay loam silty clay	Silty clay loam-silty clay-silt loam stratified	Slow	High	Slow	Slight	Severe (4L)	C	.37	Permeability; wind erosion hazard; high compaction susceptibility

APPENDIX 3.2
ECONOMIC METHODOLOGIES

The following procedures were used to estimate the economic benefits (i.e., net public benefits, business activity, employment and income). Only economic benefits from flood hazard control, sediment reduction and hunting have been quantified. No estimate was made of the economic benefits of improved wildlife habitat, better livestock production (i.e., increased calf weights, greater percent calf crop, etc.), enhancing recreation opportunities and other intrinsic values. Limitations on data do not permit quantification of other economic benefits. Economic benefits fall into two general categories. The first is the market or nonmarket value of a good or service (i.e., price paid for stumpage, willingness to pay for recreation, etc.) and will be referred to as the economic value. The other category is the benefit from increased business activity, employment and income from direct expenditures (i.e., recreation expenditures for travel, food and lodging, etc.) and will be referred to as the economic benefit.

The value of nonmarket goods and services (i.e., sediment reduction and hunting) was estimated using National Forest Service (NFS) benefit values for the 1985 program by resource activity Region 1 (see Table 6). The value of flood hazard control was estimated using procedures outlined in the SCS, National Engineering Handbook, Section 4, Hydrology.

Since benefits and costs occur at different times during the 50 year analysis period, the present value of annual benefits and costs was calculated for a comparison of one alternative with another and other resource economic values. The present value is the sum of each year's total benefits or costs discounted to the present. The benefit/cost ratios provide a relative ranking of alternatives and not the absolute benefits and costs by alternative. All values are expressed in 1984 dollars and assume an interest rate of 7⅞%.

Business activity, employment and income were estimated using coefficients from the BLM Montana Economic/Demographic Model (E/D Model). See the technical description for a detailed explanation of the E/D Model (Chase, Robert A., et al. 1982. Expansion and Adaptation of the North Dakota Economic-Demographic Assessment Model (NEDAM) for Montana. Ag. Econ. Misc. Report No. 61, NDSU, Fargo, North Dakota).

TABLE 6: NFS Benefit Values — 1985 Program by Selected Resource Activity. Region 1 (1984 dollars)[1]

Activity	Units	Value
Big Game Use	RVD	$33.72
Other Game Use	RVD	22.85
Sediment Reduction	M Tons	7.62

[1] Dollars were adjusted to 1984 using the consumer price index.

Source: USDA — Forest Service DEIS RPA 1985-2030.

Watershed

Current sediment reduction is estimated at 307,000 tons annually for the next 18 years. Sediment storage by alternative is shown in Table 7 in tons per year and years of storage.

TABLE 7: Sediment Storage By Alternative And Annual Economic Value.

	Alternative			
	1	2*	3	4**
Sediment storage (tons/yr)	307,000	307,000	572,000	231,000
Years of Storage	18	10	33	20
Annual Economic Benefits ($)	2,300	2,300	4,400	1,800

* It is assumed that over the long term no benefits would be realized from sediment storage due to the possible breaching of abandoned reservoirs resulting in increased sediment loads downstream.

** It is assumed that over the long term approximately 50% of the benefits realized from sediment storage would be offset due to the possible breaching of abandoned reservoirs resulting in increased sediment loads downstream.

Sediment reduction is valued at $7.62/M tons (see Table 6) resulting in annual economic values as shown in Table 7. Since benefits occur for different time periods, the present value of annual benefits was calculated for a comparison of one alternative with another and other resource economic values. The present values from sediment reduction by alternative are as follows (assumes an interest rate of 7⅞%):

Alternative	Present Value ($)
1	22,000
2	0
3	51,000
4	9,000

Economic value from flood control of agricultural lands is estimated at $80.82/acre in 1984 dollars. This is based on 1981 crop receipts of $28,831,000 on 406,600 acres harvested in Valley County (Montana Agricultural Statistics 1983, adjusted to 1984 dollars). Willow Creek watershed projects reduce flood hazard on 2,200 acres of agricultural lands from a 100-year storm. This reduction in flood hazard is estimated at $177,000. However, the probability of this occurrence in any given year is one percent. Also this value does not account for flood hazard control from a 50-year storm, 75-year storm or other storm frequencies. To determine the annual economic value from flood hazard control requires summing the benefits for all storms based on the probability of occurrence. For example, since a 100-year storm has a one percent chance of occurring the annual economic value is $1,770 ($177,000 × .01). Using procedures outlined in the SCS, National Engineering Handbook, Section 4, Hydrology, the equivalent annual economic value is $6,500. The present value from flood control for the 50-year analysis period is $80,000 (assumes an interest rate of 7⅞%).

With abandonment of existing structures flood control would continue depending on the life expectancy of detention reservoirs. It is assumed that there would be a gradual loss in flood control benefits with no benefits realized by the 50th year. The present value from flood control under the abandonment alternative is $61,000.

The present values by alternative are as follows:

Alternative	Present Value ($)
1	80,000
2	61,000
3	80,000
4	80,000

Recreation/Wildlife Related

Big game and upland game recreation use was estimated from the Statewide Wildlife Survey and Inventory conducted by the Montana Department of Fish, Wildlife and Parks and the 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation for Montana conducted by the USDI Fish and Wildlife Service and the USDC Bureau of the Census. Big game hunting activity is estimated at 3,910 recreation visitor days (RVD) for hunting district 630 (HD 630) and upland game hunting activity is estimated at 1,845 RVDs for Valley County (see Tables 8 and 9). Willow Creek basin lies within HD 630 and Valley County. Hunting activity was then projected for the Willow Creek basin based on acreage within the basin and total acreage for HD 630 and Valley County. This results in 1,300 big game RVDs and 200 upland game RVDs. It is estimated that the existing watershed structures contribute 10% to big game habitat and 20% to upland game habitat or 10% to big game RVDs and 20% to upland game RVDs. This results in 130 big game RVDs and 40 upland game RVDs associated with existing watershed structures. Table 10 shows the change in recreation use by alternative based on wildlife responses.

Waterfowl recreation use was estimated from data on number of ducks and geese within the Willow Creek basin. Waterfowl hunting is estimated at 160 RVDs (see Table 11). It is estimated that the existing watershed structures contribute 70% to waterfowl habitat and subsequently recreation use. This results in 110 RVDs associated with existing watershed structures. Table 10 shows the change in recreation use by alternative based on wildlife responses.

The change in recreation use is over the long term (50 years) and is the annual recreation visitor days. The annual economic value for the existing situation is $7,900 (based on NFS — Benefit Values, see Table 6). Table 12 shows the long-term annual economic value from recreation use by alternative. The change in hunting activity would not occur immediately but over the long term. Assuming a gradual change in hunting activity from the existing situation, the present values of recreation use by alternative are as follows (assumes an interest rate of 7⅞%):

Alternative	Present Value ($)
1	98,000
2	75,000
3	139,000
4	101,000

TABLE 8: Big Game Hunting Use Within Hunting District 630

Year	No. of Hunters*	Hunter Days**	Recreation Visitor Days***
1979	1,329	6,778	3,954
1980	1,162	5,926	3,457
1981	1,452	7,405	4,320
Average	1,314	6,703	3,910

* Source: Statewide Wildlife Survey and Inventory, Project No. W-130-R-13.

** Assumes 5.1 days per hunter. Source: 1980 National Survey of Fishing, Hunting, and Wildlife — Associated Recreation.

*** Assumes 7 hours per hunter day and 1 RVD equals 12 hours of hunting. Source: 1980 National Survey of Fishing, Hunting, and Wildlife — Associated Recreation.

TABLE 9: Upland Game (Grouse) Hunting Use In Valley County:

Year	Hours Hunted per Bird*	Total Birds Harvested*	Total Hours Hunted	Recreation Visitor Days**
1969	1.90	9,190	17,461	1,455
1970	1.60	7,083	11,333	944
1971	0.70	11,138	7,797	650
1972	3.50	11,648	40,768	3,397
1974	4.10	12,020	49,282	4,107
1981	0.77	8,068	6,212	518
Average	2.10	9,858	22,142	1,845

* Source: Statewide Wildlife Survey and Inventory, Project No. W-130-R-1, W-130-R-2, W-130-R-3, W-130-R-4, W-130-R-6 and W-130-R-13.

** One RVD equals 12 hours.

TABLE 10: Long-Term Recreation Visitor Days Associated With Watershed Structures by Alternative.

		Alternative			
Hunting Activity	Units	1	2	3	4
Big Game	RVD	130	0	400	130
Upland Game	RVD	40	0	100	40
Waterfowl	RVD	110	0	270	140
TOTAL		280	0	770	310

TABLE 11: Waterfowl Hunting Activity Associated With Duck and Geese Production Within the Willow Creek Basin:

	Number	Hunter Days*	Recreation Visitor Days
Duck Breeding Pairs	1,300	260	90
Duck Broods	220	120	40
Geese	130	80	30
TOTAL		460	160

* Assumes a 20% harvest, 5.5 ducklings per brood, .5 hunter days per duck and 3 hunter days per goose.

** Assumes 4 hrs. per hunter day and 1 RVD equals 12 hrs. of hunting.

TABLE 12: Long-Term Economic Value From Recreation Visitor Days Associated With Watershed Structures by Alternative.

		Alternative			
Hunting Activity	Units	1	2	3	4
Big Game	($)	4,500	0	13,500	4,500
Upland Game	($)	900	0	2,300	900
Waterfowl	($)	2,500	0	6,100	3,300
TOTAL		7,900	0	21,900	8,700

Maintenance and Reconstruction Costs

Maintenance and reconstruction costs under all alternatives would occur over a 10-year period (1986 to 1996) and maintain the structures for the next 50 years. Table 13 shows the total cost by alternative, annual cost for a 10-year period and the present value of costs. All values are in 1984 dollars and present values were calculated using a discount rate of 7⅞%.

TABLE 13: Maintenance and Reconstruction Costs by Alternative (1984 dollars).

	Alternatives			
	1	2	3	4
Total Cost	2,587,000	1,040,000	5,888,000	2,713,300
Annual Cost (10 yr. period)	258,700	104,000	588,800	271,300
Present Value (7⅞% interest rate)	1,618,000	651,000	3,683,000	1,697,000

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GLOSSARY

ACTIVITY PLANNING — Site-specific planning which precedes actual development. This is the most detailed level of BLM planning.

ALLOTMENT — An area of land where one or more livestock operators graze their livestock. Allotments generally consist of BLM lands but may also include state owned and private lands. An allotment may include one or more separate pastures. Livestock numbers and seasons of use are specified for each allotment.

ALLOTMENT MANAGEMENT PLAN (AMP) — A written program of livestock grazing management, including supportive measures, if required, designed to attain specific management goals in a grazing allotment.

ANIMAL UNIT MONTH (AUM) — A standardized measurement of the amount of forage necessary for the complete sustenance of one animal for 1 month; also, the measurement of the privilege of grazing one animal for 1 month.

CANOPY COVER — The percentage of ground covered when a polygon drawn around the extremities of the undisturbed canopy of each plant is projected on the ground and all such projections on a given area are added together.

CHANNEL STABILITY — A relative term describing erosion or movement of the channel walls or bottom due to waterflow.

CHARACTERISTIC LANDSCAPE — The established landscape in an area, not necessarily a natural area. It could refer to a farming community, urban area or any other landscape which has an identifiable character.

CLAYPAN — A dense, compact layer in the subsoil having a much higher clay content than the overlying material from which it is separated by a sharply defined boundary.

CONFLUENCE — The place where two streams meet.

DISTRIBUTION — The uniformity of livestock grazing over a range area. Distribution is affected by the availability of water, topography and type and palatability of vegetation as well as other factors.

EROSION — The wearing away of the land surface by running water, wind, ice or other geological agents.

FLOODPLAIN — The relatively flat area or lowlands adjoining a body of standing or flowing water which has been or might be covered by floodwater.

GLORY HOLE — An area below a large outlet structure which has been excavated by the water coming out of the structure. Energy from the water has eroded the soil, and created a large washed out area which undermines the structure and causes damage to the pipe.

GRAZING SYSTEM — The manipulation of livestock grazing to accomplish a desired result.

HARDPAN — A hardened soil layer caused by cementation of soil particles with organic matter or with materials such as silica, sesquioxides or calcium carbonate. The hardness does not change appreciably with changes in moisture content.

HEADCUTTING — The process where a vertical face or drop forms on the bed of a stream channel. The gully moves upstream as it is cut back by the water which flows in at its head.

HYDROLOGY — The science dealing with the behavior of water as it occurs in the atmosphere, on the surface of the ground and underground.

KEY SPECIES — Major forage species on which range management should be based.

MANAGEMENT FRAMEWORK PLAN (MFP) — A planning decision document that establishes for a given area, land use allocations, coordination guidelines for multiple use or protection. It is the BLM's land use plan. An MFP is prepared in three steps: (1) Resource recommendation; (2) Impact analysis and alternative development; and (3) Decision making.

MITIGATION MEASURES — Methods or procedures committed to by BLM for the purpose of reducing or lessening the impacts of an action.

NATURAL GEOLOGIC EROSION — The wearing away of the land's surface by running water, wind, ice or other geologic agents, unaffected by human activities.

PEAK DISCHARGE — The highest stage or channel flow attained by a flood, usually expressed as the volume of water in cubic feet passing a given point in a one second time period, hence, cubic feet/second.

PERMIT (GRAZING) — An authorization that permits the grazing of a specified number and kind of livestock on a designated area of BLM lands for a period of time, usually not more than 1 year.

PUBLIC LANDS — Any land or interest in land (outside of Alaska) owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management.

RANGE CONDITION — The present state of vegetation or a range site in relation to the climax plant commmunity of that site. It is an expression of the relative degree to which the kinds, proportions and amounts of plants in a plant community resemble that of the climax plant community for that site. Range condition is basically an ecological rating of the plant community. Air-dry weight is the unit of measure used in comparing the composition and production of the present plant community with that of the climax community.

RANGE DEVELOPMENT — A structure, excavation, treatment or development to rehabilitate, protect or improve public lands to advance range betterment. "Range Development" is synonymous with "Range Improvement".

RANGE FACILITIES — Any structure or excavation such as water sources, shade sources, oilers, etc., designed to facilitate range management.

RIPARIAN AREA — A specialized form of wetland with characteristic vegetation restricted to areas along, adjacent to or contiguous with rivers and streams, also, periodically, flooded lake and reservoir shore areas, as well as lakes with stable water levels.

RUNOFF — The water that flows on the land surface from an area in response to rainfall or snowmelt. As used in this RMP runoff from an area becomes streamflow when it reaches a channel.

SEDIMENT — Soil, rock particles and organic or other debris carried from one place to another by wind, water or gravity.

TOPOGRAPHY — The exact physical features and configuration of a place or region; the detailed and accurate description of the landforms of a place or region.

TOTAL DISSOLVED SOLIDS — The dry weight of dissolved material, organic and inorganic, contained in water.

VEGETATION (GROUND) COVER — The percent of land surface covered by all living vegetation (and remnant vegetation yet to decompose) within 20 feet of the ground.

VEGETATION MANIPULATION — Alteration of present vegetation by using fire, plowing, spraying or other means to manipulate natural successional trends.

WATER QUALITY — The chemical, physical and biological characteristics of water with respect to its suitability for a particular use.

WATERSHED — All lands which are enclosed by a continuous hydrologic drainage divide and lie upslope from a specified point on a stream.

WATERSHED COVER — The material (vegetation, litter, rock) covering the soil and providing protection from, or resistance to, the impact of raindrops and the energy of overland flow, and expressed in percent of the area covered.

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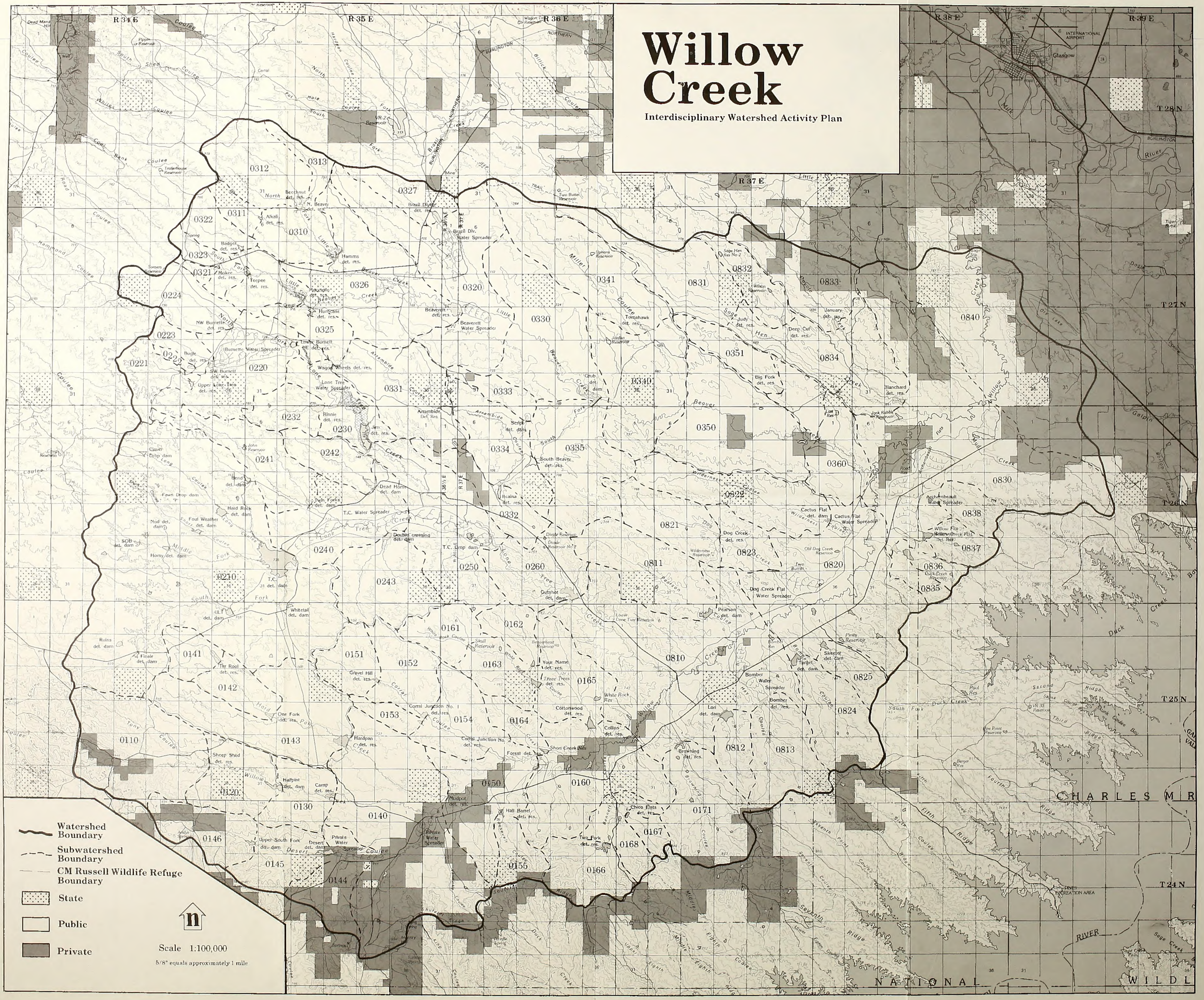
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